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EMPIRE COFFEE.

THE present situation in the world with regard to the marketing of coffee has recently been reviewed by the Imperial Economic Committee, whose findings are embodied in a comprehensive Report* which should not only be of interest to the trade but also to all producers and consumers of the staple.

It appears that the consumption per head of population in the United Kingdom is very much smaller than that in the United States, the relative proportions being about one to twelve. This is because tea is drunk in much larger quantities in the United Kingdom than it is in the United States and also because the British consumer prefers and can afford coffee of good quality, while in the United States there is a wide popular demand for Brazilian or "bulk" coffees. Thus, the United Kingdom and London, in particular, has come to be recognised as the principal market in Europe for coffee of high quality. The importance of the London market to Empire growers is not perhaps due so much to its own requirements but to what it is capable of absorbing as a re-export market since nearly half of the coffee which finds its way there is re-exported. Of this half Empire coffees represent 45 per cent. At present it is unlikely that there will be a large increase in the consumption of coffee in the United Kingdom as this has remained more or less stationary since 1925. In the United States, on the other hand, there has been a tendency in recent years towards the consumption of a larger percentage of good medium grades of East African coffee. The demand for coffee in that country appears to have been governed more by an increase in population than by any increase in the actual consumption per head.

With regard to production it is surprising to find that although the British Empire produces some of the best coffees in the world, only 3 per cent. of these enter world trade. Since the war, however, there has been a considerable expansion in the production of Empire coffees and to this, the new areas in East Africa have chiefly contributed. Of the older areas of production India is finding a steadily expanding home market, while Jamaica supplies nearly the whole of its "Blue Mountain" coffee to the United Kingdom. More recently between 70 per cent. to 80 per cent. of the total coffee exports from Jamaica and Trinidad have been diverted to Canada. While the older areas have not shown any signs of increased production

* Imperial Economic Committee. Nineteenth Report.

the development of coffee areas in East Africa is not yet over. The coffee produced there is, however, rapidly winning its way in the world markets on account of its quality. Production in the Empire has mainly been confined to the "mild" varieties or high grades of coffee. Of the foreign areas Brazil is a long way ahead of any other as it produces between 60 per cent. to 70 per cent. of the world's coffee supply. Of the others, the Dutch East Indies and Colombia have recently shown advances in production, while Costa Rica has maintained its supply of high grade coffees.

In view of what has just been stated it will be seen that the general position in the world of Empire coffee is not too unfavourable. British coffee planters will have, however, to envisage a period of keen competition, specially as the uncertainty of the situation in Brazil may affect to a certain extent the prices of the "mild" coffees. The reputation of Empire grown coffee has been built up in competition with the best grades of coffee from foreign countries, and Empire growers, particularly in the newer areas, should take as their standard for that market the strength of Costa Rica, their chief competitor, which supplies very carefully blended coffees of uniform quality. Much can still be done by the adoption of an efficient marketing organisation. In Kenya, where estates, in contrast to South American countries, are for the most part small in size and scattered, co-operation in matters of grading and curing of coffee will be difficult but once achieved should confer most material benefits on the planters. The importance of evenness and uniformity of grading cannot be over emphasized as the possible maintenance by Empire growers of a uniform standard blend is well worth keeping in view. There are many factors which affect both the appearance and quality of the coffee bean and in this respect it is satisfactory to know that provisions have already been made both in East Africa, at the Amani Research Institute, and in Mysore, the chief growing coffee district in India, to study many urgent problems in regard to the crop. Last but not least, little is known by the British public on the actual preparation of the beverage and the Committee have quite rightly given up a large part of their Report to this subject. Coffee might be a more popular drink in the United Kingdom if it were prepared with the same skill as is used in its preparation on the Continent. The Committee have laid special stress in their Report on the importance of using freshly ground coffee in suitable proportions and have outlined quite simple methods of preparation which, if properly followed, should go far to remove one of the chief obstacles which at present hinder the appreciation of coffee in the United Kingdom.

The coffee industry has, like all other industries, suffered from the general depression and has been further embarrassed by the results of over production in Brazil, a factor which is likely to influence the situation for some time to come. Nevertheless, the fall in prices of the best grades of Empire coffees has, on account of their quality, been relatively less severe than it might have been. This general level of quality should in some measure protect Empire coffees from the severity of the slump but it will have to be maintained if their future position in world markets is to be assured.

BIOLOGICAL CONTROL IN MAURITIUS.

MAURITIUS, like many other sugar-cane growing countries of the world, suffers severely from the ravages of Lamellicorn beetle larvae. The species *Phytalus smithi* appears to have been accidentally imported into Mauritius from Barbados, some time prior to 1911, when it was first recorded as a pest. Good work has been achieved by various artificial methods of control, and this has been augmented by the application of biological measures. In 1916, the solitary wasp, *Tiphia parallela*, was introduced from Barbados and has now become well distributed over the whole region of infested cane. The present-day position of the problem is described by Mr. D. d'Emmerez de Charmoy, in the issue of the *Bulletin of Entomological Research*, Vol. XXII, No. 1. He points out that since the *Phytalus* has been well established in Mauritius, some twelve or fifteen years before the introduction of its parasite, the latter is, for the time being, at a disadvantage from the economic point of view. Years must elapse before it can increase to the point where it will exterminate a sufficient proportion of the host population to yield the desired degree of control. At present the *Tiphia* destroys up to 30 per cent. of the *Phytalus* and its work is being augmented by a second parasite, *Elis thoracica*, which was imported from Madagascar in 1917. At the present juncture, it may be said that artificial measures of control are required to be rigidly prosecuted so long as the biological method remains only very partially efficacious.—(*Nature*, Vol. CXXVII, No. 3216.)

REPRINTS.

The following reprints of articles which have appeared in the Journal can be obtained on application to the Editor :—

Banana Fruit Diseases	C. W. Wardlaw	6*d.*
Bananas in Storage and Transport	C. W. Wardlaw and L. P. McGuire	6*d.*
Fruit and Vegetable Storage	L. P. McGuire	6*d.*
Panama Disease Research	C. W. Wardlaw	4*d.*
Soils and Flora	C. W. Wardlaw	6*d.*
Cacao Research	W. G. Freeman	6*d.*
Early Maturity in Cotton	S. C. Harland	2*d.*
Limes and Withertip	R. O. Williams	6*d.*
Trinidad Cotton Research Station	S. C. Harland	6*d.*
Rationalisation (Pts. I-V)	H. M. Leake	6*d.*
Labour Efficiency	E. A. Seagar	6*d.*
Defective Diet	E. A. Seagar	6*d.*
Parasitology in the Tropics	T. W. M. Cameron	4*d.*

TROPICAL DAIRYING PROBLEMS.

By John Hammond,
School of Agriculture, Cambridge, England.

[*A paper read at the International Dairy Congress, Copenhagen, July, 1931.*]

This paper presents a survey of the problems of tropical dairying based on a short visit to the Government Stock Farms in Jamaica and Trinidad. To Mr. H. H. Cousins, Director of Agriculture and Dr. S. Lockett, Chief Veterinary Officer in Jamaica, and to Captain H. V. Metivier, Chief Veterinary Officer and Director and Dr. J. L. Shannon, Manager of the Government Stock Farm in Trinidad, my thanks are due for having put at my disposal all their records and results. To Lieut.-Col. J. Matson and others my thanks are also due for information on results obtained in other tropical countries.

The need for a better milk supply in the Tropics is great for, as Seagar's (6) results show the diet of the native population is very deficient in animal proteins, and although this may not be the cause of actual disease in adults, it is associated with a high infantile mortality and much inefficiency in adults.

Feeding Problems.

Things which have a seasonal distribution have also a geographic range, and an interesting comparison can be made between the seasonal variation and geographic differences in milk yields. Sanders (5) has investigated the seasonal variation in the yields of cows in two different districts in England, which show (*see* Fig. 1) that on the average in commercial herds, the yield rises at the time the grass begins to grow in the spring and falls again as the hot weather begins and the grass matures and becomes fibrous. Woodman's (7) work on the composition of grass has shown that in the early stages of growth it is a concentrated food (plus water) and that its high protein content, high digestibility and low fibre content make it a very suitable food for milk production purposes. As the grass gets older, however, and especially after the flowering shoots appear, lignified fibre is formed, the proportion of protein and the digestibility fall and the bulkiness is increased. Thus even in England where the supply of concentrated feeds is abundant, commercial herds on the average show well marked seasonal changes due to the type of roughages fed, for a large proportion of the cow's food intake in commercial production always consists of home grown forages or grazing. High producing animals have not the capacity to hold the bulk of food required to supply sufficient nourishment to support high yields where the feeding stuffs are of low quality and contain much fibre: this is the main cause for low yields under commercial conditions.

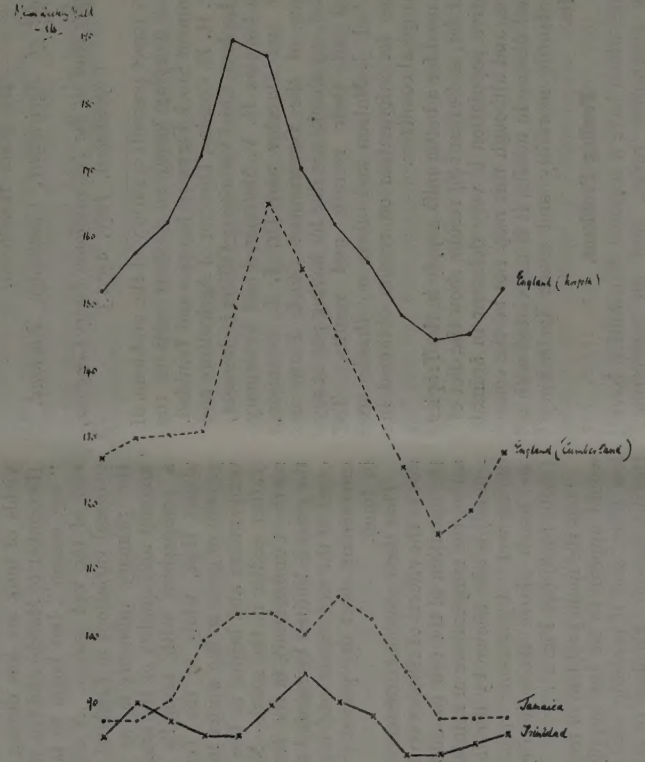
The seasonal variation in the milk yields will then give a measure of the feeding value for milk production of the forages used during the different months of the year. These have been calculated from milk records obtained under tropical conditions in Jamaica and Trinidad (Fig. 1): the yields of milk are low during the "dry season" (December to March) and rise with the onset of the "wet season", but begin to fall again before the end of the wet season. A comparison with the seasonal variations in England (Fig. 1) shows that the primary influence is, as stated above, the amount and quality of the grasses and forages, for a comparison with rainfalls and temperatures shows that, while in the Temperate Zone the growth of grass in the winter months is limited by temperature and begins as this rises in the spring (rather earlier in the south—Norfolk, than in the north—Cumberland), in the Tropics the growth of the grass is limited by rainfall and begins with the onset of the wet season, and is reduced during any intervening short dry period (*see* Fig. 1, Jamaica in June).

That these seasonal differences in milk yields are due to the effects of climate on the plant and so on the nutrition of the cow (in addition to any direct action the temperature or rainfall may have on the animal) is also shown by the fact that in Jamaica during wet "dry seasons" (1925, 1927) the yields are much above those in dry "dry seasons" (1926, 1928) (*see* Fig. 2).

Thus the main problem of feeding in the Tropics would appear to be the supply of high protein, low fibre, and if possible, succulent foods during the dry season. Ensilage of grass or forage crops in the early stages of growth in either the tower or pit silo, or irrigation of pastures are methods which are being used with success. Forages on the whole in the Tropics, like those in England during the hot weather, soon develop fibre and become bulky and unsuited for milk production (*see* analyses Barnett (1)). Much variation exists however among the different grasses and there is much scope for the selection of low fibre and high protein species. Digestibility trials of those in common use, are also now being made at the Imperial College of Tropical Agriculture in Trinidad. In the Temperate Zones, the deep rooting and high protein leguminous plants such as lucerne and white clover supply a high protein feed during the summer months and these not only supply suitable food for growing and milking animals, but also raise the fertility of the soil by fixing nitrogen. At present no such leguminous crops are cultivated in the West Indies, and the discovery and use of such would do much to improve cattle production in the Tropics.

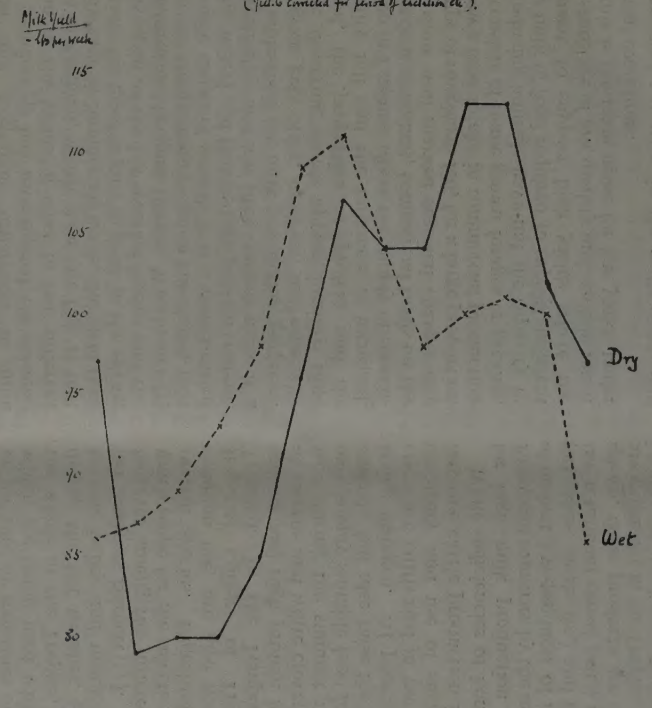
While deficiencies of home grown forage crops for high milk production can be made up in European countries by the use of the comparatively abundant bye-products of industrial manufacture (oil cakes, meals, &c.) and in Temperate Zones by the rotational cereal (oats) and pulse (bean) crops grown, these products are difficult to obtain and are expensive in the Tropics. The local production of coconut meal may in the future supply such a product, but the prevailing tendency in the West Indies for the cultivation of trees and perennial crops to the exclusion of annual crops (which is

Fig. I - Seasonal variations in Milk Yields



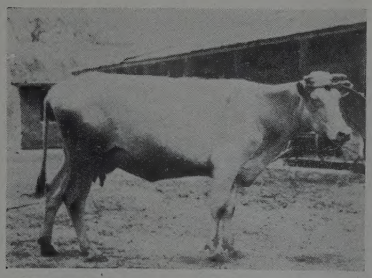
	Month:	Jan	Feb	Mch	Apl	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Temp. °F	Lancashire	37.6	38.8	41.7	46.0	52.6	57.7	61.3	60.7	56.7	49.5	43.1	38.8	37.4
	Cumberland	34.7	37.1	39.5	43.9	49.6	55.7	58.4	57.0	53.2	44.7	40.7	37.4	34.9
Rainfall - inches	Jamaica	1.09	1.24	1.32	3.26	6.95	1.88	2.30	7.34	7.06	6.31	7.00	1.69	1.09
	Trinidad	3.19	1.88	1.45	2.07	3.72	5.85	7.20	7.50	8.01	6.37	6.01	3.16	3.19

Fig. II - Comparison of milk yields in Wet and Dry "dry-seasons" (Jamaica)
(Yields corrected for period of lactation etc.)



		Nov	Dec	Jan	Feb	Mar	Apl	May	June	July	Aug	Sept	Oct.	Nov.
Rainfall - inches	Wet	7.20	3.19	1.90	2.34	2.68	6.00	3.99	1.75	3.85	3.08	8.62	9.8	7.20
	Dry	6.35	3.77	0.43	0.81	0.59	1.83	5.20	1.72	1.25	12.75	5.84	7.27	6.35

TROPICAL DAIRYING PROBLEMS.



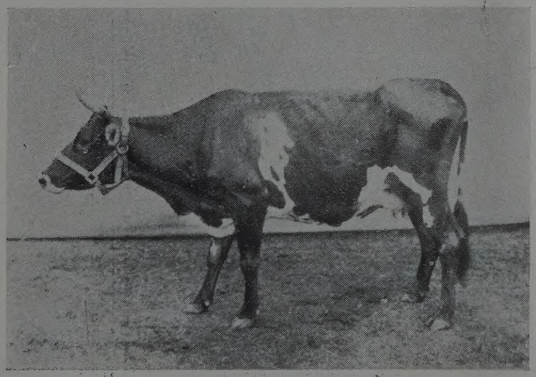
(8) ECHO GELDERTJE CHAMPION—Pure bred Friesian. Imported as 3 year old
Aged 4 years

(9) NANDRANI—Pure bred Zebu (Hissar type)
Aged 9 years

(21) ARABELLA—Friesian. Zebu (1/4 Zebu). Aged 6 years
Sire: King Buttergirl Walker (Friesian).
Dam: Bluebell (1/2 Friesian 1/2 Zebu)

(13) BLUEBELL — Friesian-Zebu (1/2 Zebu). Aged 15 years.
Sire: Alick (Friesian) Dam: Natoria (Zebu)

PLATE I *illustrates the types of animals crossed* (8) *Friesian x* (9) *Zebu with the result in the first generation* (13) *of an animal combining the constitution of the Zebu with the udder development of the Friesian. The back cross to the Friesian* (21) *shows good udder development but not such good constitution as the first cross.* (*Trinidad experiments.*)



VICKIE A. High Grade Jersey Cow. (1/16 Zebu)
Sire: "Tipperary" (Zebu Jersey) (1/8 Zebu)
Dam: Pedigree Jersey.
Record 16 lbs. Milk. Aged 12 Years. Weight 670 lbs.

PLATE II *illustrates effect of adding Zebu blood to a high grade Jersey which is beginning to show signs of degeneration. This cow crossed with a Montgomery Zebu bull produced the animal shown in Plate III which had a stronger constitution and gave more milk than the dam.* (*Jamaica experiments.*)

VICKIE C. Zebu-Jersey Cow (17/32 Zebu)
Sire: "Pusa". Dam: "Vickie A"
Record 28 lbs. Milk. Aged 6 Years. Weight 1160 lbs.

PLATE III. *Progeny from cross between cow shown on Plate II and Montgomery Zebu bull.*

BANANA DISEASES.

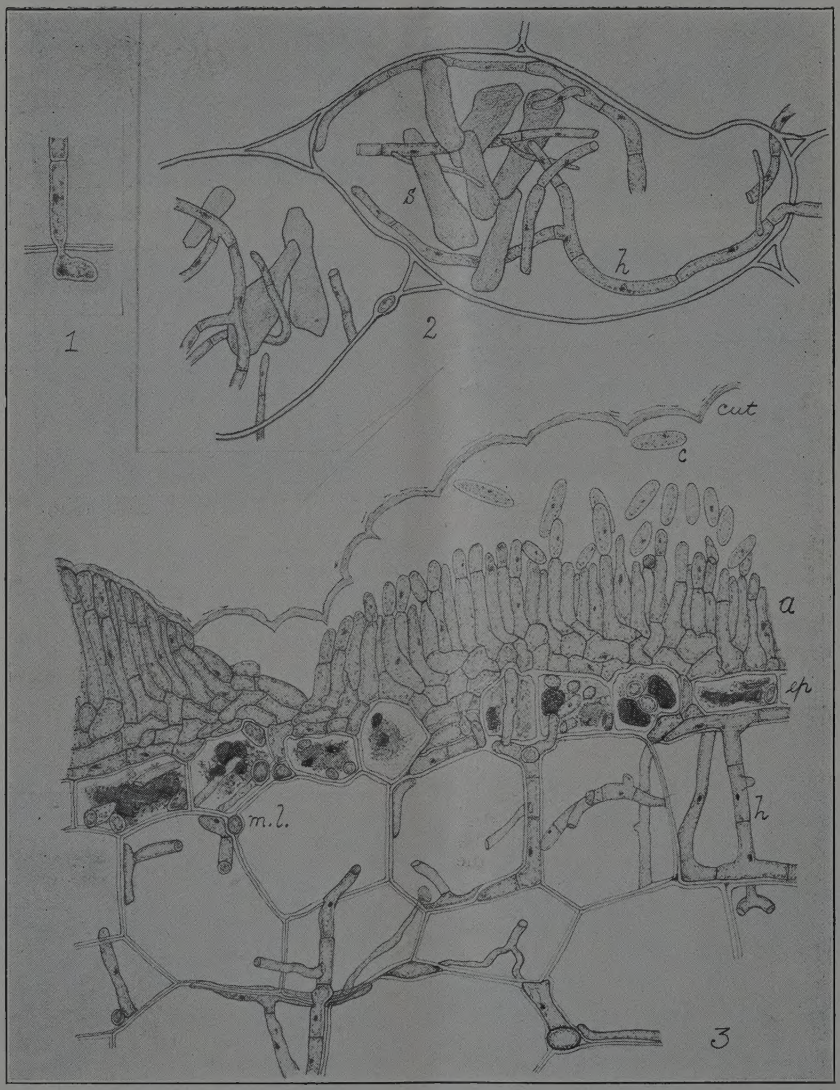


FIG. 1.—*Passage of a hyphal tip through a cell wall.*

FIG. 2.—*Hyphae (h) in the inner tissues of the skin. The starch grains (S) have not been affected by the presence of the fungus.*

FIG. 3.—*Section through a conidial pustule or acervulus: cut-cuticle; h—hyphae; m.l.—hypha in middle lamella; a—acervulus; c—conidia.*

encouraged by the nature of the climate) will always limit the local supply of concentrated feeding stuffs of this nature and render their importation necessary for high production. One of the functions of the animal in agriculture is to form a means of cashing those crops, or bye-products of crops, which are not fitted for human consumption direct. Of the staple crops which are grown in the West Indies, the sugar cane is almost the only one which supplies such bye-products suitable for feeding cows: the tops in the cutting season and the molasses form useful feeding stuffs and a variety called Uba cane which produces an abundance of leafy growth, is particularly valuable for this purpose. A peak in the milk production curve about February in Trinidad (*see* Fig. 1) is probably due to the use of these fresh cane tops during the cutting season. It is necessary that improvements in feeding should go hand in hand with breeding, for unless this is done the nutrition will either limit the yield of cows with high milk capabilities or undermine their constitution so that they die at an early age.

Management.

The problems of management vary greatly in different districts according to the availability of pasturage, &c., and the details, although very important, can only in a few cases be drawn into general statements. Under natural conditions cattle graze in the early morning and evening and lie in the shade during the middle of the day when the sun is hot. Housing during this part of the day not only falls in with this natural desire for shade, but allows of the feeding of concentrates according to yield and may be used to increase the intake of water (by the addition of a little molasses to it: and concentrates if in meal form may also be fed in this way). Provision of shade, and so the continuance of feeding throughout the day, is in some areas in Jamaica obtained by the use of the Peruvian rain tree (*Pithecolobium Saman*) which allows grass to grow under it: a combination of these trees with small wired-in paddocks receiving water from neighbouring irrigated land and managed by a system of rotational grazing, appeared to give excellent results during the dry season.

Breeding.

Cattle in the Tropics have not been improved to the same extent for either milk or meat production as they have been in the Temperate Zones. From time to time importations of South American, European and Indian (Zebu) cattle have taken place and the present native stock, the survivors of these various importations, is very mixed. Various methods of improvement have been tried and the following are the main conclusions reached :—

(*a*) *Selection of native stock*:—This method is very slow. Great difficulty is experienced in breaking in the animals to be milked; having been used mainly for work purposes, they do not let down their milk unless a calf is being suckled or other means are taken (*see* Duerst's account (3)) and they frequently fail to breed again until the calf is weaned or the milk yield falls. Possible methods of overcoming this difficulty are the haltering of young stock to induce docility and the selection of sires from docile dams. The method of selection of this stock would, however, prove slow although not impossible.

(*b*) *Importation of European stock* and grading up of native stock with these. At first very good results were obtained by this process, but just as it is found difficult to keep and breed pure European stock in the Tropics commercially because of a variety of causes which require further study and analysis (disease resistance, heat regulation, &c., but summarized as constitutional disabilities), so the stock which had been graded up by the use of European bulls for three or more generations failed to produce much milk and became degenerate. Table I (prepared by Mr. J. Edwards) for example shows that in the Tropics a very well bred Guernsey bull used on high grade European cows reduced rather than increased the milk yields.

TABLE I.

Progeny of a Guernsey bull used on high grade European cows.

Corrected Mature Milk Yields.	Lb.
Average of 11 dams	.. 5,200
Average of 11 daughters ..	.. 4,800
	— 400

Of the various European breeds tried, the Shorthorn and Ayrshire appear to have a constitution least suited to the Tropics and signs of degeneration appeared at a lower concentration of their blood than those of other breeds (Friesian, Jersey, Red Poll) more adaptable to tropical conditions. It would appear that a long thick coat and white skin are inimical characters in the Tropics: periodic clipping is essential for the health of such animals. The methods of importing pure European stocks and the grading of native cattle to such stocks appear to offer no solution of the problem of breeding commercial dairy cattle in the Tropics.

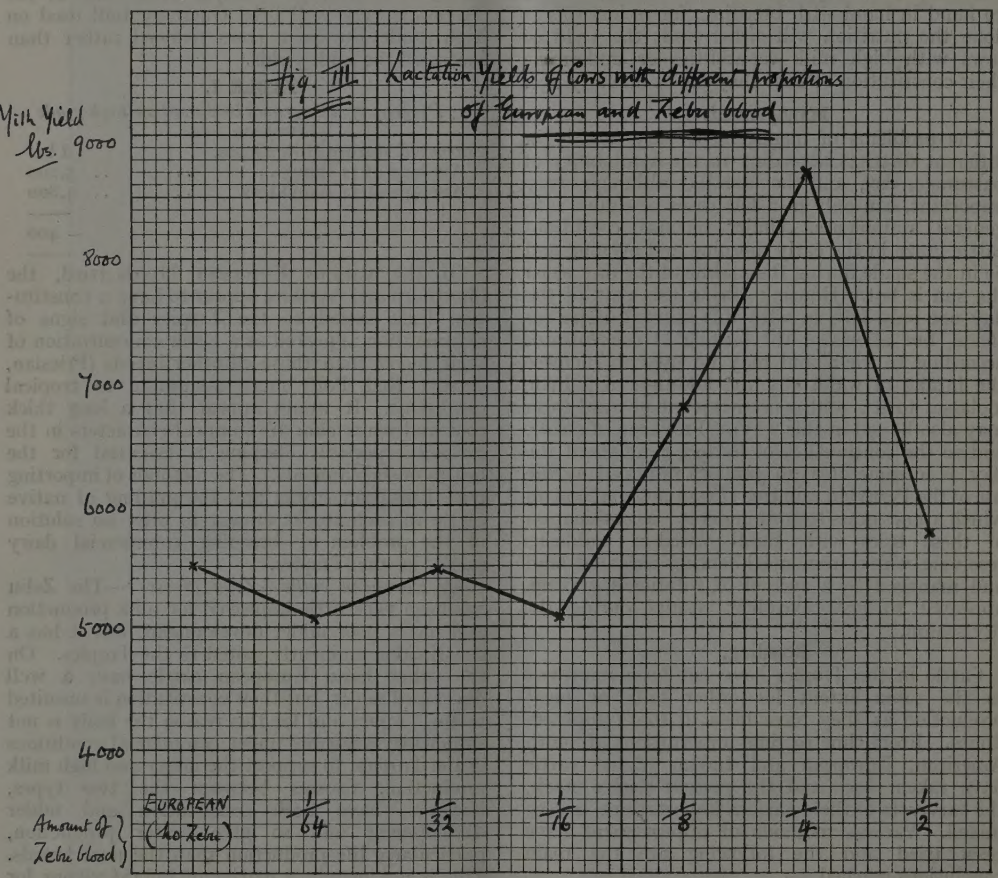
(*c*) *European cattle—Zebu crosses*:—The Zebu has been very little improved for milk production and has a poor udder development, but it has a constitution eminently suited to the Tropics. On the other hand European cattle have a well developed udder, but their constitution is unsuited to the Tropics and for this reason the body is not sufficiently vigorous under commercial conditions in the Tropics, to support the udder and high milk production. Crosses between the two types, however, have both constitution and udder development and so give better production, particularly life production than the pure breeds. This is not merely a matter of hybrid vigour for different European breeds crossed together in the Tropics give no better results than those breeds when pure. On the other hand it was surprising to find that the use of a pure Zebu bull on high grade European cows (although he came from a lower milk yielding strain) increased instead of lowered the yields (see Table II).

TABLE II.

Progeny of a Zebu (Montgomery) bull used on high grade European cows.

Corrected Mature Milk Yields.	Lb.
Average of 10 dams	4,730
Average of 10 daughters	5,700
	+ 970

It is believed that both constitution and udder development are multiple factor characters in inheritance and this being so it would follow that, cattle having many chromosomes, the inheritance of these characters is fairly accurately described by Galton's law of blending inheritance or percentages of blood (*see* Lush (4)). If this is so the first point to determine is what proportions of Zebu and European blood give the best results under any climatic conditions. Fig. 3 (prepared by Mr. J. Edwards) shows the results obtained in Jamaica : $\frac{1}{4}$ to $\frac{1}{8}$ of Zebu blood appears to give the best results. Conditions here, however, are not so severe as may exist elsewhere in the Tropics, where a higher proportion of Zebu blood may be required. These results are taken from lactation periods in the years 1923-28 only and probably a more certain estimate of the proportion of Zebu blood best suited to commercial milk production would be obtained if the life production of the different grades were considered. As the proportion of European blood is increased from half to three-quarters and seven-eighths so the average lactation yield will go up, but the cows do not last so long in the herd and their life production becomes less.



Promiscuous and repeated crossbreeding, however, does not lead anywhere, although the trial of the different European breeds has been necessary in the beginning to find out which were best. Once this is determined it is better to keep to one breed and its crosses with the Zebu and avoid that promiscuous mixing of breeds which leads only to mongrels.

Although the fancy points such as colour and horns segregate sharply when the first crosses are bred together, there is every indication that the commercial qualities of constitution, body form and milk yield (which appear to be multiple factor characters) do not segregate sharply and only vary about a mean (as ear length and body size in Castle's (2) rabbits). If this mean produces a profitable commercial animal, the numbers to be weeded out will, therefore, be small, and there would appear to be no reason why a new breed of dairy cattle suited to the Tropics should not be produced by breeding together whichever grade of Zebu-European cross give the best results in a district. The Suffolk, Dorset Down and Corriedale breeds of sheep have been produced in this way.

The evolution of such a new breed could best be obtained by its being adopted on a large scale in a given area, so as to allow of interchange of blood between herds; and by the formation of a herd book which would act by segregating such animals from the common stock, a primary necessity in the creation of a new type. As with European cattle the chief difficulties would be met with in the bulls: the cows could be selected on their milk yields but the bulls could only be selected by progeny tests.

Marketing.

The high temperatures in the Tropics make this a troublesome matter, for without precautions the milk will not keep sweet long. Consequently it is found that, as in England many years ago, the family cow is kept in towns and forage is brought in to feed her. Town dairies, where only a few hours elapse between milking and consumption are also numerous; but such milk is comparatively expensive to produce, due to the high cost of the land and the transport of food. Town dairies in Great Britain have almost disappeared since the pasteurization of milk has been adopted. In the West Indies clean milking, cooling, bottling and keeping the cans in cold storage and ice are being used in some districts, but these methods are comparatively expensive and while the extra cost is willingly paid by the European population the price is too high for the large proportion of the native population. As in Great Britain it would appear that pasteurization and bottling would afford the best means of ensuring a safe and cheap supply of milk for the bulk of the population. Such a process would, as it has done in England, extend the radius from which a town could collect its milk supply.

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COCOA PLANTERS' ASSOCIATION.

Report for 1930-31.

DURING the year ended 30th June, the Cocoa Planters' Association established a new record by disposing of a crop of 68,204 bags (each of 165 lb.) compared with the previous record of 58,975 during 1929-30. Some 15 years ago, when the Association was incorporated as a Company limited by guarantee, the crop handled was only 18,267 bags. During 1930-31 membership increased from 236 to 254 estates. Unfortunately a new record was also established in low prices, the gross receipts averaging $7.71 a fanega (110 lb.), from which 11 cents a fanega was deducted for working expenses, leaving a net return to members of $7.60 a fanega. This figure, although extremely low, nevertheless represents a high average when market conditions prevailing throughout the year are taken into consideration. The actual working expenses amounted to only six cents a fanega, enabling five cents a fanega, amounting to $6,612.06, to be added to the Deferred Deposit Fund which now stands at $53,335.78.

During the course of the year the members sanctioned the marketing of "Superior Quality C.P.A. Cocoa" and some 2,300 bags were disposed of at a net return of $8.70 per fanega. The principal market for this grade is London where the demand is limited to between 2,000 to 3,000 bags per annum, and as shipments have to be consigned, sales are slow. Efforts are being made to establish additional markets for this superior grade. For the first time the premium obtained for this cacao was distributed among the members producing it, and not, as hitherto, bulked with the general receipts for the Standard grade. This substantial and welcome addition to the low prices obtained for the Standard grade should stimulate members to greater efforts in the preparation of their cacao, and generally tend to enhance the reputation of Trinidad cacao. It was also agreed that the Chairman should be paid $10, and each of the Directors $5, for every fortnightly meeting attended by them.

Yields throughout the Island were generally good though in the south of the Island and in Manzanilla a severe drought resulted in seriously reduced yields. It is satisfactory to note that properties infected by Witchbroom again showed increased returns, due, it is believed, to the greater attention paid to cultivation. Stocks of cacao in the chief consuming countries are exceptionally low and the general statistical position of the product is good. Provided no important disturbance arises in the general political situation, it is anticipated that prices will show an appreciable rise during the coming crop.

C. Y. S.

STORED PRODUCTS RESEARCH.

The Work of the Stored Products Research Laboratory, Imperial College of Science and Technology.

By C. Potter, B.Sc.

[*The following article describes briefly the origin and work of the Stored Product Research Laboratory of the Imperial College of Science and Technology under the direction of Professor J. W. Munro.*]

Introductory.

Until quite recently the attention of economic entomologists and mycologists has been devoted almost exclusively to problems arising from insect and fungus infestation of growing crops. Large sums of money have been spent on the investigation of insect and fungus diseases, expenditure which has been justified by results of economic importance in the formulation of successful control measures. It is well known that much work remains still to be done in plant protection, but it is now being realized by producers and their biological advisers that even after the crop leaves the field, wastage sufficiently serious to make produce unmarketable sometimes takes place. Thus manufacturers are awakening to the incalculable financial losses due to the deterioration of raw produce caused by insects and moulds and now realise that those which affect stored products are quite as important as those affecting the growing crop. Although the financial loss caused by the deterioration of raw products by infestation cannot be assessed accurately, it is known to be exceedingly great. In addition, and this seems to carry most weight, there is the loss of commercial prestige infested material reaching the public.

There are two main reasons why this branch of economic entomology has been neglected hitherto. In the first place the producer is often unable to obtain exact information regarding the condition in which his produce reaches the buyer, though occasionally he may receive complaints and because he is ignorant of this, he is not encouraged to take action. In the second place, there is the difficulty of deciding where the responsibility for the damage actually lies; whether the damage was done before, during, or after transportation. This difficulty has made all the parties diffident about taking steps, since this would involve the admission of responsibility for the damage. In this connection it may be said that there are quite a number of instances where products are infested and investigation is urgently required, but the people concerned will not admit the need since they are afraid that their competitors in trade, who, incidentally almost certainly have the same complaint, will use the fact to their discredit.

In the U.S.A. several institutions are concerned with research on the pests of stored products and in Germany a stored products research laboratory was established in 1920 in the Biologische Reichsanstalt fur Forst und Landwirtschaft, but nothing was done in England until 1926, when the Entomology Department of the Imperial College of Science and Technology began a preliminary investigation into the insect infestation of cacao. After collecting information which showed the importance of the problem, the College approached the Empire Marketing Board for funds to extend the work and in 1928, with the help of a series of grants from this body, a private residential building in Slough was acquired which has now become the Stored Products Research Laboratory under the direction of Dr. J. W. Munro, Professor of Entomology in the College.

In the organization of this work, the recommendations of the Royal Society Grain Pests (War) Committee on the organization of grain pests work, were taken as a basis and the Stored Products research work is conducted along the lines suggested in the Tenth Report of that Committee. At present the investigation can be divided under three headings :—

(*a*) Survey work (Entomological and Mycological).
(*b*) Biological research (Entomological and Mycological).
(*c*) Chemical research.

Survey Work.

This is carried out at the warehouses, docks, factories, and mills, and may be said to correspond to field work in agricultural entomology and mycology. It forms the point of contact between the commercial and the scientific sides. The survey work is undertaken for the purpose of estimating the nature and amount of the damage and of ascertaining the history of the produce, including the possibility of infestation before shipment, in transit, or in the store.

The work in this section may be classified under three heads :—

(*a*) Interrogation of merchants, manufacturers and warehousemen with regard to the troubles they encounter.
(*b*) Inspection of incoming produce.
(*c*) Examination of storage places.

With regard to the first head, interviews with merchants and manufacturers have frequently provided the staff with invaluable information regarding the produce under investigation, and their co-operation in the work is essential to ascertain the requirements of the market.

Since the staff is small, no general survey of all the produce coming into England has been attempted as yet. Preliminary surveys of insect conditions prevailing in certain cacao stores, at certain wharves and docks in London (*vide* E. M. B. Report 24, Munro and Thomson, December, 1929), and of the condition in which copra is landed have been undertaken. It is now proposed to make a wider survey of the London warehouses in order to obtain a more general idea of conditions prevailing, and to make a wider inspection of incoming produce. In addition, a more detailed study of the dried fruit and cacao problems will

be made. The scheme of cacao inspection has been extended to include Liverpool, whence samples are sent to Slough for systematic examination. An account of this extension scheme would serve as a typical example of inspection work. The suggestion that a systematic survey of West African cacao should be made on its arrival in this country met with an encouraging response from the importing firms in Liverpool and three of the largest of them agreed to send regular samples of every shipment throughout the 1930-1931 season. It is thought that the examination of the numerous samples which are being received will provide sufficient data to permit statistical examination with reference to the total output of cacao from West Africa.

The main objects to be attained are :—

(1) A figure representing the percentage of cacao beans which are "commercially damaged" by insects and moulds before landing.

(2) The relative proportion of infestation by each species of insect found in cacao before its entry into the warehouses in the United Kingdom.

(3) Details of the species of moulds present in cacao at the time of its arrival with comparative figures of their prevalence.

(4) The relationship between insects and mould growth.

(5) The moisture content of cacao when landed and its relationship to the moulds and insects present.

(6) The comparative susceptibility to attack of :
(i) germinated beans,
(ii) "slatey" beans,
(iii) fermented beans.

(7) The relationship between the time of shipping and the degree of attack.

It is intended that those shipments which are stored for a considerable time after landing shall be kept under observation and their condition ascertained periodically for comparison with the original data relating to them. The results already yielded by such inspection have been sufficiently satisfactory to justify the extension of the work to cacao from other sources and negotiations are afoot to start a similar sampling scheme for cacao from Guayaquil.

Although it has been ascertained that infestation both by insects and moulds occurs generally before shipping, there is usually no convincing evidence as to the origin or the magnitude of this primary infestation. This is particularly true of such insects as, by virtue of their mobility, are able to infest produce at all stages in their life history except the egg. On this account, produce is sometimes inspected aboard ships on its arrival at London, since a clearer idea is so obtained of what has happened during the voyage than by inspection after landing. The question of storage in the ship is frequently complicated in vessels with a mixed cargo, since many insects which attack stored products are polyphagous—and consequently there is a possibility that they may spread from one commodity in the cargo to another.

On the question of warehouse conditions it can usually be said that any particular warehouse specialises in a particular product such as cacao or a particular variety of products such as cacao, spices and coffee. Now with the same products continuously being brought into the same warehouse, a standing population of insects which attack that product often becomes firmly established, and with this standing population there is always the risk of infecting the clean produce which enters. Re-infestation in the warehouse is not proven but seems very likely. In those cases of cacao and dried fruits where a detailed investigation has been attempted, the products are inspected as soon after landing as possible. A percentage of the boxes of dried fruit is opened and inspected on landing, while cacao samples are drawn by official samplers and sent to the laboratory for examination. By these means some idea is obtained of the infestation of the goods as they arrive in the country.

It is hoped that in future, co-operation will be established between exporting countries and ourselves, so that from time to time consignments of goods that have been inspected in the country of origin may also be examined on arrival; comparison of the two reports will thus show the progress of infestation during transit.

Experiments are now being carried out to determine the actual conditions of temperature and moisture prevailing throughout the year in storage places and to determine the chances of the re-infestation of produce. The life history in the warehouse of the most important pests of cacao and dried fruit is also being worked out, since laboratory experiments afford little index to the insect's behaviour under the conditions obtaining at the docks.

The survey work further includes the consideration of three additional questions in the case of each product :—

(1) The length of time that the product usually spends in the warehouse.

(2) The hands through which the product has to pass.

(3) The manufacturing treatment which it receives before reaching the consumer.

If the product is likely to remain for a long time in the warehouse, as frequently happens with cacao, a small primary infestation may become serious through the multiplication of the organisms present in the first instance.

If the product passes through a number of hands before reaching its final destination, it is quite possible that any one of these stages may be a point of infestation.

Cacao undergoes very drastic treatment, such as roasting and grinding, before eventually reaching the consumer and this is sufficient to kill any insects which may have been present, although a great deal of damage may have been effected already, and there is still risk of a subsequent infestation.

Dried fruit, on the contrary, reaches the consumer as raw material and the risk of infected fruit reaching the consumer is consequently much greater and more difficult to avoid.

Co-operation with Exporting Countries.

It is obvious from what has been said, that in survey work co-operation with exporting countries is necessary in order to complete the history of a product with an account of its experiences before shipment. Co-operation in the cacao work was anticipated from the Gold Coast as being the largest producer of that commodity. Nigeria, however, has undertaken to report on the moisture, mould and insect contents of marked commercial consignments, which are being examined at critical stages between their production and shipment, and in other ways to assist in the ultimate work of control. Trinidad has afforded useful information regarding local cacao moulds; Australia and New Zealand have been in touch with the Slough institution, the services of which, it is hoped, will be utilized by any other part of the Empire which requires a report upon the condition of its produce exported to the United Kingdom, or on any question arising from biological deterioration.

Biological Research Work.

(*a*) *Entomology.*

It is hoped to base the entomological work on a thorough understanding of each insect concerned, especially with regard to the details of its life history and physiology.

Only a small amount of life history work has been done so far, but such investigation has already been found in some species to be complicated by the variation between individuals of the same species reared under apparently identical conditions; especially is this variation marked in differences of length of the life cycle. The tendency of certain moths (*Ephestia* and *Plodia*) under laboratory conditions to become infertile is another matter which may be of great economic importance.

Preliminary experiments have been carried out at various controlled temperatures and humidities with *Sitotroga cerealella* Ol., a moth which does considerable damage to Indian corn and other grain in storage and the results point to possible ways of control, especially by regulation of the humidity.

Various experiments with extreme temperatures have been carried out. In general, very low temperatures alone effect a complete mortality of stored products insects (with *Plodia interpunctella*, double freezing at $-10°C$ is required), and the cost is usually prohibitive except with valuable products. Cold storage, while useful for keeping insects inactive, may lead to heavy loss from certain species when the goods are taken out of cold store, unless consumption follows immediately.

Probably one of the most important, and at the same time, fascinating problems of control work by the use of heat, cold, or fumigants, is the varying resistance found between differen species and even between individuals of the same species. A proper understanding of the reasons for individual resistance is likely to simplify control work. The use of fumigants and extreme heat or cold should be regarded as temporary measures and final control should be based on a study of methods of harvesting, shipment and storage in relation to the pests.

(*b*) *Mycology.*

Mycological laboratory work on the deterioration of produce opens up a field which, it is felt, may be regarded as a distinct branch of economic mycology, with its own problems of fundamental importance, distinct from mycological plant pathology. An institution for the investigation of these problems is developing rapidly at Slough and from it, co-ordinated work on moulds may be expected.

It is proposed to make a study of the systematic position of the organisms encountered, to determine their physiological reactions, their effects upon the various products and to ascertain their vital requirements. With the staff as at present organised, little can be done besides dealing with the determination of species found on samples received from surveys, from casual enquirers, from experimental consignments and from produce under experimental storage. Experience of this work has shown the inadequacy of the available knowledge on the morphology of the moulds, particularly in the matter of individual variations, and the apparent impossibility of applying much of the published physiological work to organisms insufficiently defined and described. Accordingly fundamental work on the systematics as well as on the reactions of the moulds concerned will be attempted, thus bringing order where there is at present only confusion.

Chemical Research Work.

It is hoped that eventually the present extensive use of chemicals in combating insects will be abandoned in favour of stricter hygiene, but this will probably not be possible for many years. In the meantime there is much to be discovered about their more efficient use. The research required will relate to fumigants for the most part, since these are the only really effective insecticides.

The fumigants concerned must have special characteristics on account of the work they will be required to do. They must, in the first place be toxic to insects and, if possible, harmless to man. Secondly they must be cheap to use and available in quantities large enough to meet commercial requirements. Another desideratum is that they should damage neither the produce nor the building in which the produce is housed and, in addition, they should disappear completely after use, leaving no taint. Probably not the least important attribute of a fumigant for use on stored products is that of good diffusion, so that it may permeate all parts of infested substances and of the storage shed. Finally there

is the question of fire risk. Many fumigants, highly desirable in other respects, are yet highly inflammable, and experiments are being undertaken to ascertain the possibility of reducing that risk by mixing these gases with others which combat fire.

Research is being undertaken to ascertain the effectiveness of various recognised fumigants for particular use on stored products.

In determining the toxicity of a fumigant several factors have to be considered and it is difficult to take some of these into account. The following items are important :—

(*a*) The strength of the dose.
(*b*) The duration of the exposure.
(*c*) The temperature and humidity of the air.
(*d*) The rate at which the air is moving.
(*e*) The species, stage in life cycle, previous life history and capacity for individual variation in resistance of the insect.

In practice, the dosage, the duration of the exposure and the temperature are considered and in order to eliminate as far as possible all likelihood of individual resistance affecting the issue, healthy insects are employed in large numbers. In work of this kind the dose giving a 50 per cent. mortality is used as a standard for comparison, but of course 100 per cent. mortality is the actual practical aim.

Experiments on a laboratory scale are limited in value, since the conditions occurring in a commercial fumigation cannot be reproduced exactly in a laboratory. It is proposed, however, to adopt two methods to overcome this difficulty. The first method involves erecting a plant with which it is possible to fumigate commercial quantities of a given product, such as a sack of cacao or a 56 lb. box of sultanas, under controlled conditions. The second method is that of experimental fumigation in the warehouses themselves.

The plant proposed for fumigation of commercial quantities takes the form of an upright steel cylinder, water jacketed, and with a vacuum tight padded lid closed by a central screw and carried on a trolley. From this cylinder connections lead to gas cylinders and measuring appliances and, in addition, to a pump and exhaust chimney, since it is proposed to experiment with vacuum fumigation and fumigation under pressure. There is also between the cylinder and the pump a cold trap which serves the triple purpose of protecting the pump from harmful vapours, of condensing and reclaiming the fumigant if required and finally of providing a cold chamber, capable of attaining −40°F., for the experimental freezing of insects.

The application of the results obtained at the field station to actual commerical practice will take the form of experimental fumigation of products in warehouses, barges, &c. The word 'experimental' is used advisedly in this connection, since it is not proposed at this stage to consider special trade problems, but to give a general guide which will enable each trade to solve its own difficulties. These large scale experiments under commercial conditions are naturally the last to be started partly because they rest on the smaller scale studies, and partly because there are so many parties interested in them that some time is necessary to make harmonious arrangements. However, opportunities are fast developing, and it is to be hoped that close co-operation will be established with the trade in this, the final part of the work.

It was previously stated that fumigants were regarded as the final solution of the chemical aspect of the problem, but other subsidiary measures are being investigated, such as the contact insecticide spray and the live steam jet for use in the sterilization of storage places. Whilst concentrating on the direct method of the use of insecticides, it is proposed to attempt to find some theoretical basis for fumigation. To do this it is hoped that an investigation may be undertaken on the physiology of insects, particularly insect respiration. The entomological is co-operating with the chemical section in this work.

Besides the actual control of the insect, questions arise in connection with deterioration of goods or produce which the chemical section is called upon to settle ; questions such as the nature of a white incrustation on damaged prunes, or whether a sample of mouldy rubber has been wetted with fresh or sea water.

It is found that produce grown in certain areas, apparently differing but slightly from badly attacked material, enjoys comparative immunity. This in itself forms an interesting problem in urgent need of investigation but its study would involve special research in physiological entomology and micro-biochemistry, and for the time being at least, only problems of immediate and fundamental importance can be attacked.

Since its inception the Stored Products Research Laboratory has investigated in some detail the question of infestation of cacao, dried fruit and tobacco and to a lesser extent, copra. None of these matters has been investigated to the full, but the cacao question may be cited as an example of what the study of any one product may lead to. Investigation of the insect infestation of cacao has resulted so far in :—

(1) A survey of insect conditions prevailing in the cacao warehouses of London.

(2) A revision of the moths of the genus *Ephestia*.

(3) An investigation into the causes of sterility of the moths *Ephestia kühniella* and *Plodia interpunctella*.

(4) A regular examination of West African cacao arriving in Liverpool.

(5) The discovery of internal moulds not hitherto reported as infecting cacao and distinct from those known to result from imperfect preparation.

(6) Confirmation of the opinion that Actinomycetes are a cause of 'mustiness' of cacao beans.

(7) Investigations into temperature and moisture conditions in warehouses.

(8) Investigation of the power of the insect pest to over-winter in England, and the consequent possibilities of infestation and re-infestation.

The fact that so many questions arise from the study of one product will give some idea of the magnitude of the work. In connection with the survey work on insect infestation a short list of some products with the more important insects found attacking them is appended. A complete list of recorded insects is not given, but only those which are causing the damage together with a few secondary pests :

Cassia Fistula.

Frequently arrives showing signs of bad insect attack but no live insects are found.

Insect remains found on it were :—

Trachylepidia fructicassiella (Lepidoptera).
Dinoderus sp. (Coleoptera).
Plochionus pallens (do.)
Cathartus cassiae (do.)

Cacao.

Frequently arrives badly infested, five species of insects being responsible for most of the damage.

The insects responsible are :—

Ephestia elutella (Lepidoptera).
Ephestia cautella (do.)
Araecerus fasciculatus (Coleoptera).
Tribolium castaneum (do.)
Tribolium confusum (do.)

Of these, the two species of *Ephestia* are by far the most important, since they are capable of carrying on their life cycle in the warehouses here, and have become established wherever cacao is stored. St. Lucia cacao is affected by a moth *Corcyra cephalonica* which, so far, has not been troublesome in other cases.

Nutmegs.

Very frequently nutmegs come into this country badly infested. Infested nutmegs have to be separated from the sound and this process involves hand picking. The following are the five most prevalent species, although a large number of others is recorded by us.

Araecerus fasciculatus (Coleoptera).
Carpophilus dimidiatus (do.)
Oryzaephilus (*Silvanus*) *mercator*(Coleoptera).
Tribolium castaneum (do.)
Tribolium confusum (do.)

Of these, the most important species are *Araecerus fasciculatus* and *Carpophilus dimidiatus*. The damage has been done for the most part by the time the goods arrive; *A. fasciculatus* and to a lesser extent *C. dimidiatus* do not seem to be able to withstand our cold climate.

Mace.

The insects recorded on mace are the same as those on nutmegs, as is to be expected. In addition to these species of insects, however, quite a number of species of earwigs (*Dermaptera*) are introduced with the product. At present it is not known whether these are harmful or not.

The insects attacking it are :—

Araecerus fasciculatus (Coleoptera).
Tribolium castaneum (do.)
Oryzaephilus (*Silvanus*) *mercator* (Coleoptera).
Dermaptera lobia spp.

Copra.

This is badly attacked by insects and is also frequently coated with moulds.

The insects attacking it are :—

Necrobia rufipes (Coleoptera).
Oryzaephilus (*Silvanus*) *mercator* (Coleoptera).
Oryzaephilus (*Silvanus*) *surinamensis* (do.)
Tribolium castaneum (Coleoptera).
Alphitobium diaperinus (do.)

The most important pest is *Necrobia rufipes*, which causes a large amount of damage. *Oryzaephilus mercator* and *O. surinamensis* are also prevalent. *Tribolium castaneum* and *Alphitobius diaperinus* do not seem to occur in any large numbers over here.

Ginger.

Ginger fairly frequently arrives exhibiting severe insect attack, due to the following species :—

Caulophilus latinasus (Coleoptera).
Lasioderma serricorne (do.)
Dinoderus minutus (do.)
Carpophilus dimidiatus (do.)
Gnathocerus cornutus (do.)

All these insects cause damage and although *Caulophilus latinasus*, *Lasioderma serricorne* and *Dinoderus minutus* seem to be the three most important, there is no very definite evidence on this head.

Dried Fruit.

Dried fruit is very liable to insect attack and since in the normal course of events the fruit undergoes no process calculated to destroy insects before reaching the consumer, the infestation is a serious matter.

The insects attacking it are :—

Plodia interpunctella (Lepidoptera).
Ephestia elutella (do.)
Ephestia cautella (do.)

Several other species occur from time to time but the three mentioned above are of far the most economic importance. The following secondary pests are recorded :—

Carpophilus ligneus (Coleoptera).
Carpophilus hemipterus (do.)
Carpophilus dimidiatus (do.)
Oryzaephilus (*Silvanus*) *surinamensis* (Coleoptera).
Oryzaephilus (*Silvanus*) *mercator*, (Coleoptera).

Tobacco.

Two major pests occur in stored tobacco and these are the cause of some anxiety over here, since they are sometimes the cause of serious losses.

The insects attacking it are :—

Ephestia elutella (Lepidoptera).
Lasioderma serricorne (Coleoptera),

Of these *Lasioderma serricorne* has been recognised for some time but *Ephestia elutella* has become recognised as a pest only in the last two years and it seems to be spreading. The appearance of *E. elutella* as a pest is thought to be due in the main to the accumulation and prolonged storage of tobacco in warehouses, consequent upon overproduction. Our experiments show that *E. elutella* attacks only bright flue cured tobacco. A detailed investigation into the tobacco question supported wholly by the tobacco trade is in progress at the College.

Extension.

Enough has been said above to indicate the scope of the work planned or in progress, something has now to be said of the need for extension.

The widespread distribution of the parts of our Empire, involving as it does the transport of vast quantities of produce from the tropical or semi-tropical countries to the temperate zones, makes sound harvesting, shipment, and storage, of the highest importance. Storage is itself rapidly becoming one of the vital problems in Empire trade and development. The regulation of supply to demand depends on ability to store, and ability to store depends very largely on a knowledge of all the organisms causing deterioration of food stuffs and other raw materials and of the factors favouring or inhibiting their development. The Stored Products Laboratory at Slough will, it is hoped, become a centre of information on storage problems and its development is being planned as far as possible to that end. It may be claimed that the organisation of the work at Slough is unique in that, although the Laboratory is attached to the Entomology Department, all three sections of it, entomological, mycological and chemical are each and all directly concerned with stored products problems in general and are not regarded as separate entities.

We look forward to close co-operation with the producing countries, the very nature of the work needs such co-operation, while demanding the centralisation of the whole in Great Britain. As co-operation spreads and our experience grows, we shall be able to fulfil our function the better. Our various departments are accumulating and will continue to accumulate an ever widening experience of the successful handling of produce, by virtue of the many different but related problems with which a central organisation, such as this, is obliged to deal. We regard as a very valuable extension of our present programme the training of men to extend the work both here, and in the producing countries.

NOTICE.

THE subscription to *Tropical Agriculture* is six shillings per annum, post free, Trinidad currency, to all countries within the British Empire or seven shillings and six pence, post free, Trinidad currency, to all other countries. Subscriptions can commence at any time during the year.

CACAO MANURIAL EXPERIMENT.

A cacao manurial experiment which was recently concluded at Peradeniya is described in the *Tropical Agriculturist* (Vol. LXXVI, No. 5). Sixteen one-acre plots were divided into four groups of four plots each, each group containing one plot of each treatment. The treatments were as follows :—

A plots 250 lb. of superphosphate per plot per annum.

B plots 100 lb. of muriate of potash per plot per annum.

C plots 250 lb. of superphosphate and 100 lb. of muriate of potash per plot per annum.

D plots control—no manures, but the same cultural treatment as the manured plots.

All manures were applied in January of each year, and lightly forked in, while the D plots received a similar forking at the same time. In each group the control plot (D) was not selected by randomisation but the plot which had given the highest average yield over the four years prior to the first application of the manures was taken. Conclusions were to be based on the average annual yields of the A, B, and C plots relative to the D plots without manures during the four cacao years 1923-24, 1924-25, 1925-26, and 1926-27, compared with the average annual yield of the A, B, and C plots relative to the D plots with manuring in the four cacao years 1927-28, 1928-29, 1929-30, and 1930-31. In other words, since the D plots were in each group the highest yielders in the first period, it was intended to see whether the lead of the D plots over the A, B, and C plots was reduced by manuring the latter. In addition to yields, the intention was to study the effect of manuring on pod canker incidence by comparing the proportion which good cacao formed of the total crop in the two periods.

From the yields obtained it was found that on the average the application of superphosphate and muriate of potash (A and B plots) had not improved the position of these plots. With a mixture of the two manures the yield was improved on the average by 2.3 per cent. but the experiment as a whole did not afford any evidence that the yield had been increased by the application of any of the manures used. It was also found that no influence had been exerted on the incidence of pod canker.

A NEW ENCYCLOPAEDIA.

Messrs. Bailliere, Tindall & Cox, 17 and 18, Henrietta Street, Covent Garden, London, inform us that they have recently issued an "Encyclopaedia of Scientific Agriculture" with the object of placing at the service of the farmer and scientific investigator results of research that are capable of immediate application to agriculture, horticulture, market gardening, &c. To the production of this book some eighty leading experts have contributed.

GLOEOSPORIUM STRAINS.

Notes on thirty-two isolations of Gloeosporium from bananas in Trinidad.

By S. F. Ashby,
Mycologist, Imperial Mycological Institute.

[*These notes, in which a systematic account is given of different strains of 'Gloeosporium' associated with the banana, are based on thirty-two isolations of this fungus sent from Trinidad by Dr. G. W. Wardlaw on 8th March,* 1931, *and 23rd April,* 1931.]

The cultures may be divided into three groups:—

(1) A group represented by the large majority (21 or about 66 per cent.) which may be regarded as the *normal type*.

(2) A group showing a more or less appreciable variation from the normal type (7 or about 22 per cent.)

(3) A group developing perithecia (4 or 12 per cent.). In three of these asci and mature ascospores were present.

Group I.

This covers the cultures with the undermentioned numbers :—

1	8	13	21	27
2	9	14	22	
5	10	16	23	
6	11	17	25	
7	12	20	26	

With the exception of No. 17 these isolations were on slopes of Brown's synthetic potato dextrose agar. On this medium the normal type develops numerous uniformly scattered, medium-sized, orange-pink, slimy (gelatinous), conidial masses, each borne on a more or less blackened independent basal tissue arising directly from the agar surface, no persistent aerial mycelium being present. Between the acervuli the medium is colourless as no plectenchyma of dark coloured hyphae is produced. In older cultures the mycelium in the agar develops numerous dark brown or smoky appressoria on the under surface of the agar against the glass.

On this medium the conidia are very uniform in shape and vary in size within only a narrow range. There is no tendency for them to germinate *in situ* so that the conidial masses retain their original character for long periods. On slopes of quaker oats agar inoculated with spore suspensions and maintained at 23°C, the growth and spore production is quite similar, with at first a very slight aerial mycelium which soon disappears, conidial production being completed in about a month ; on this medium the conidia are also quite similar in shape and size to those on the Brown's agar. On malt agar and Dox's agar the type of growth and conidial production are similar but the conidia are markedly more variable in shape and size. It is evident that the Brown's agar and the quaker oats agar are the best media for the production of uniform normal conidia. On these two media the conidia are very dominantly oval in shape, the contour showing a slightly convex curvature ; they are either symmetrically oval or slightly narrower at the proximal end ; the contents show moderate granulation and a clear spot is more or less marked at or near the middle. A small minority may have parallel lateral walls and a more pronounced narrowing at one end.

Cultures isolated from *green fruit* in Ceylon sent by M. Park and cultures from *ripe fruit* in the Central Provinces, India, sent by J. F. Dastur, have been grown in parallel culture on quaker oats agar with some members of this group and have given a quite similar growth and conidial production. The conidia were also not to be distinguished in shape and size from those in the cultures from Trinidad. It is evident therefore that the normal type is widely distributed on the fruit and that a form on green fruit in Ceylon does not differ from one on ripe fruit in India.

Measurements of 40 conidia from acervuli on Brown's agar or quaker oats agar are shown in the table which follows :—

No.	*Mean.*	*Range.*	*Ratio*($\frac{l}{b}$).
1	13.85×5.4	12-17 × 5-6	2.56
2	13.65×5.7	11.5-17 × 5-6.5	2.4
5	13.65×5.75	12-17 × 5-6.5	2.4
8	13.9 ×6.1	12-16 × 5.3-7	2.3
9	14.0 ×5.5	12.5-15.5 × 5-6.5	2.6
10	13.4 ×5-7.5	12-15.5 ×5.3-6.5	2.3
11	12.85×5.55	12-15.5 × 5-6.5	2.3
12	12.55×5.8	12-14.5 × 5-6.5	2.16
13	13.6 ×5.8	12.5-15.5 ×5.3-7.0	2.3
14	12.4 ×5.8	11.5-14.5 ×5.3-7.0	2.14
16	13.7 ×5.8	12-16 × 5-7	2.4
Ceylon (*a*)	13.8 ×5.5	12-16 ×5.3-6	2.5
(*b*)	14 ×5.35	12-16 × 5-6	2.6
India	13 ×5.8	11-16 ×5.7	2.25

Group II.

This comprises the cultures with the undermentioned numbers :—

15	24	30
18	28	
19	29	

These cultures showed mostly a scanty but persistent aerial mycelium, fewer acervuli and in several a very marked reduction in spore production.

No. 15 showed persistent slight aerial mycelium and fewer and larger acervuli. The conidia were more irregular in form than those in the first group. The normal oval form was well represented, but many were parallel-sided, others somewhat concave-sided and narrowing at the proximal end was more marked. The variation from the normal was on the whole only slight.

No. 18.—The orange-pink conidial masses were fewer and larger with practically no persistent aerial mycelium. A number of the scattered black

stromata showed no coloured spore masses and the medium at and below the base of the slope was blackened by an internal growth of dark-brown mycelium. An examination of the black stromata showing no pink conidial masses revealed the fact that conidia had been produced but had germinated *in situ*; the germ tubes had anastomosed and fresh conidia had been produced on the short germ hyphae and had again germinated. The germinated conidia were septate, often markedly constricted and showed brown walls. A dark compact weft had in this way been formed overlying the stromatic base of the acervuli. The conidia were as variable in shape as those of No. 15.

No. 19.—Showed appreciable persistent white aerial mycelium but no dark coloured mycelium within the medium. The black stromatoid acervuli scattered over the slope showed no persistent pink spore masses. Examination showed that conidia had been produced in scanty numbers but had germinated *in situ* with the same appearance and effect as in No. 18. In the culture no ungerminated conidia could be found.

No. 24 was very similar to No. 15.

No. 30 was intermediate in character between 18 and 19.

Nos. 28 and 29 were much alike with a quite appreciable persistent greyish white aerial mycelium and an abundant growth of olive brown mycelium in the medium rendering it black and opaque. Black stromatic acervuli were numerous but small, with no persistent pink spore masses. Conidia soon after production had germinated *in situ* and none ungerminated could be found.

These seven cultures represented a series connecting the normal type of the first group with the extreme variation shown by 28 and 29. The tendency was towards an increase in aerial mycelium and dark-coloured internal mycelium, accompanied by more pronounced sclerotioid development of the acervulus, reduction in conidial production and readier germination of the conidia *in situ*. The conidia were more irregular in shape than those in the first group but fell within the range of that group in length; whereas none of the first group was found under 5 microns in width, some of this group were down to 4.5 microns. The mean size was about 14.2×5.3 and the range 12-17×4.5-6.5.

Group III.

The four cultures in this group were 3, 4, 31, and 32.

No. 3 showed on Brown's agar a persistent scanty, greyish-white, aerial mycelium and olive-brown mycelium within the agar rendering it dark and opaque. A few scattered, large, orange-pink conidial masses were present. The conidia were rarely of the oval shape, being usually with parallel sides and rounded ends, or slightly concave and with one end not infrequently somewhat enlarged and the other rather pointed. They showed the usual granulation and the clear spot at or near the centre. They were slightly longer than those of the normal type the mean size being 14.5×5.24 and the range 11.5-19×5-5.6.

Perithecia were produced in a few black roughened patches; they were spherical to subspherical in shape and closely aggregated (caespitose) without any stroma. The asci were ellipsoid with a pedicellate base and paraphyses were absent. The ascospores were allantoid (curved) the curvature being frequently pronounced; they were hyaline, continuous and granular, with a clear spot at the centre and with equally rounded ends.

Measurements are shown below:—

perithecia 120-170μ
asci 60-80×11-13
ascospores: mean of 90=16.4×4.93
(approx. 16.5×5)
range 13.5-20.5×4-6 (commonly 15-17×4.5-5.5).

No. 4.—This culture on Brown's agar was similar in appearance to No. 3, the conidial masses being more numerous but smaller. The conidia were also similar in shape being dominantly parallel-sided but somewhat shorter and narrower. The mean size was 14.2 × 5.13 and the range 12.5-17.5×4.5-5.5. Perithecia were produced in black roughened patches being closely aggregated (caespitose) and without a stroma. They were spherical to sub-spherical in form but most had failed to reach full size (a few were up to 120μ in diameter) and the contents were either homogeneous or cellular but without any trace of differentiation of asci.

No. 31.—The culture on Brown's agar showed a characteristic arrangement of the black stromatoid acervuli in transverse bands separated by clear zones (corresponding to concentric ring formation in plates); the individual stromata tended to become confluent. Aerial mycelium was not present and no dark coloured mycelium had formed in the agar but appressoria had developed beneath the agar in contact with the glass. Persistent pink conidial masses were present in some of the acervuli, but were not apparent on most due to early germination of the conidia *in situ* and browning of their walls. The conidia, very uniform in size, were dominantly parallel-sided with occasional slight concavity and tendency to be narrower at one end; bent and wedge-shaped forms were present but uncommon. They were mostly 13.5-15.5×5-6. In the spore beds mingled with the conidiophores *dark rigid setae* were present. Among the conidial stromata were black roughened patches of caespitose perithecia which had also developed on the conidial stromata. They were for the most part spherical or subspherical but some showed broad hyaline beaks. Asci and mature ascospores were present in many of the perithecia. The ascospores were allantoid like those in No. 3 but longer and narrower.

Measurements yielded the undermentioned figures :—

perithecia	100-150
beaks (where present)	80-90 long × 60 at the base and 45 near the apex.
asci	50-75 × 10-13
ascospores	mean 19.4 × 4.7 ; range 14.8-23.8 × 4-5.

No. 32.—This culture was not quite comparable with 3, 4 and 31, being on a different agar medium. An appreciable persistent grey to brown aerial mycelium was present with scattered black acervuli devoid of pink conidial masses. Germinated septate conidia with brown walls were present on a number of the acervuli which bore *dark rigid setae* among the conidiophores. Patches of caespitose perithecia were present containing asci and ascospores. The ascospores which were hyaline, continuous, and granular with a medium clear spot, were straight and either equally or unequally convex laterally with obtuse ends and shorter than those in 3 and 31. The mean size was 14.4 × 5.6 and the range 12.5-17 × 5-6.3.

Remarks.

Dimensions of Conidia of the Normal Type (Group I).

On Brown's agar and quaker oats agar the mean size of the conidia of fourteen isolations including those from Trinidad, India and Ceylon ranged from 12.4-14 × 5.13-6.1 and the limits of the range in size from 11.5-17 × 5-7. On malt agar and Dox's agar there was greater irregularity in shape and size, the range on the first-named being increased to 10-20 × 5-7 and on Dox to 8.5-19 × 5.3-7.

Gloeosporium musarum Cke. and Mass. was recorded (*Grev.*, XVI, 3, 1887) as having conidia 10-12 × 4 and these dimensions were copied by Saccardo (*Syll.*, X, 461). On the sheet bearing the type specimen (on the skin of a ripe fruit, Brisbane, Queensland, 1885) in Herb. Kew. Miss Wakefield has noted that the dimensions range from 12 to 20 × 5, with a mean of about 15 × 5, indicating that the original measurements were incorrect. Laubert (*Gartenflora*, LIX, 409, 1910; *Syll.*, XXII, 1189) found the conidia on some fruit imported into Germany to range from 9-24 × 5-7 and proposed for this form *G. musarum* var. *importatum* being unaware of the actual dimensions of those on the type specimen. Agati ('Banana Stem and Fruit Rot,' *Philipp. Agric.*, X, 411, 1922) recorded some measurements from cultures arranging them in classes, but mentioning neither the mean size nor the mode. Most of the conidia were in the classes 13.5 to 15.5 in length and 5.5 to 7.5 in breadth.

Toro ('Studies on Banana Anthracnose,' *Journ. Dept. Agric.*, Porto Rico, VI, 3, 1922) appears to have recorded his measurements of conidia only from the fruit. He found the maximum range on all of eight varieties to be from 11-24 × 3-6 with a mode of 11-17 × 3.5-4.5. Shear and Wood recorded from a culture a range of 9-28 × 4.5-6.5. Lasnier (*Bull. Soc. Myc.*, France, XXIV, 17, 1908) found the conidia on the fruit (origin not stated) 16-20 × 6-7. Krüger who isolated an ascosporic strain from ripe fruit imported into Germany found the conidia on the fruit 15-17.5 × 4.6-6. On culture media they were mostly 14-18 × 4.6-5.7. The dimensions of the conidia on the fruit are not strictly comparable with those in culture and in both instances show considerable variation even on the same variety and on different culture media. The uniformity of the normal type on Brown's agar and quaker oats agar is, however, noteworthy. Toro's low figures for width on the fruit seem to need confirmation especially as his drawings show oval conidia of the normal type. Although the term 'acervulus' has been used for the conidium producing structure in culture, it is not quite comparable with that on the host. On the host a shallow, flat stroma of pseudoparenchyma forms below the epidermis or cuticle on which a palisade of conidiophores is produced, rupturing the covering host layer and extruding through the break the orange-pink spore mass. In culture conidia are produced in three ways :—

1. In minute heads (cephalosporium) on short conidiophores arising at any point on the surface or immersed hyphae.

2. On palisades of conidiophores arising at discrete points on the surface or aerial hyphae.

3. In scattered black hemispherical, subspherical, or irregular (when confluent) stromatoid outgrowths of the surface mycelium ; these have a pseudoparenchymatous structure and are chambered in the young stage, the cavities are lined by branched conidiophores and eventually open to the surface exposing the hymenial layer. Both Lasnier and Toro refer to these structures as pycnidia, the first-named giving a detailed description of them. Krüger calls them pseudopycnidia. They were characteristically present in all cultures, both conidial and ascosporic.

Similar bodies have been observed in cultures of some other species of *Gloeosporium* and *Colletotrichum*.

The Ascosporic Strains.

Krüger (F) appears to be the only author who has recorded the isolation of an ascosporic strain from banana ('Beiträge zur kentniss einiger Gloeosporien,' *Arb. Kais. Biol. Anst. Land und Forst.*, IX, 233, 1913). He made a careful study of this strain together with a conidial form from apple and an ascosporic strain from tomato in Germany and an ascosporic strain from apple in Virginia, U.S.A. (furnished by Dr. Shear). He found the conidia of the American apple strain similar in size (see above) and shape to those of the strain from banana ; they were dominantly

parallel-sided, occasionally concave, and often narrower towards one end agreeing therefore in size and form with those of numbers 3, 4 and 31. Setae were sometimes present in the acervuli of both strains. The ascospores were in both instances allantoid and similar in size. Comparative measurements of the ascospores follow :—

Apple strain, U.S.A.	allantoid	14-18 ×	4.6-5
Banana	do. (Krüger)	do.	15-18.4 × 4.6-5.3
Do.	do. No. 3	do.	13.5-20.5 × 4-6 (commonly 15-17 × 4.5-8.5)
Do.	do. No. 31	do.	14.8-23.8 × 4-5
Do.	do. No. 32	straight	12.5-17 × 5-6.3

Krüger's isolation from banana infected both wounded and unwounded yellow fruit but only wounded green fruit. It infected wounded apple fruit (but doubtfully unwounded fruit) and both wounded and unwounded tomato fruit. The American strain from apple behaved simil arly but also infected unwounded apple fruit. The optimum for growth of both strains was about 30°C and both grew (slowly) at 36°C. Neither grew at 5°C but did grow (slowly) at 9½°C. It is probable that No. 3 is identical with Krüger's from banana and perhaps also No. 31.

The optimum for growth of the conidial European strain from apple was about 26°C and it grew slowly at 5°C but would not grow at 36°C. The American apple strain and the banana strain were referred by Krüger to *Glomerella rufomaculans* (Berk.) Sp. and v. Schrenk. which is synonymous with *G. fructigena* (Clint.) Sacc. and according to Shear and Wood ('Studies of Fungous Parasites belonging to the genus *Glomerella*,' Bur. Plant Ind., *U. S. Agric. Bull.*, 252, 1913) with *G. cingulata* (Stonem.) Sp. and v. Schrenk. Krüger proposed *Gloeosporium fructigenum* Berk. *forma americana* Krüg. for the conidial stage of the ascosporic strains from apple and banana.

The three strains 3, 31 and 32 (and 4 also) can be referred to *G. cingulata* as the ascosporic stage in them comes within the range of variation of that species as recorded by Shear and Wood. The conidial stage is rather similar to that on citrus (*Colletotrichum gloeosporioides* (Penz.) Sacc.) and on a number of other hosts such as mango and avocado and it is not improbable that these ascosporic strains have a wide host range under natural conditions. It is probable also that they differ somewhat in physiological and pathological behaviour from the purely conidial strains on banana which can be referred to *G. musarum* Cke. and Mass. It is also not unlikely that similar if less pronounced differences exist between the conidial forms of the normal type and the more extreme variations represented by such strains as 28 and 29. Such extreme differences in growth habit as occurred between the conidial strains A and B (Wardlaw and McGuire : *Empire Marketing Board Report*, No. 36, 1931) have apparently not been found in the present series of cultures of conidial strains.

LIVERPOOL COTTON ASSOCIATION.

By R. G. Wood.

The Liverpool Cotton Association has been in existence since 1882. Before that date there was a Cotton Brokers' Association, whose business was chiefly to sell cotton that had been consigned to, or imported by merchants, for which they charged a brokerage. In the early days most of those connected with the trade, merchant and broker, transacted their business on the Exchanges Flags, an open space unprotected from, and exposed to all weathers. Later, an official Exchange was opened in the then Browns Buildings which has since been demolished. In November, 1906, the present Exchange was opened by the King, then Prince of Wales.

Incidentally during these 25 years, American Middling cotton has been quoted as low as 3½*d.* and as high as 28*d.* and Egyptian Sakel from 6 up to 120*d.*

The Association is a Limited Company, whose constitution forbids the payment of dividends. Originally there were 600 shares issued at £100 denomination, £20 per share of which has only been paid. The shares vary in value and cannot be bought unless the intending purchaser has applied for membership and has been approved of by the Board of Directors. A recent exception has been made whereby a member can secure a share for a son engaged in the business in anticipation of the son becoming a partner. Owing to various causes such as retirement, failure or death there are usually a few shares on offer to intending members. The present value is about £700. An intending member, having been approved of by the Directors, must be proposed and seconded by existing members and elected by ballot by at least 50 clear votes. It is not often that once the Directors have approved the application that the applicant is turned down, but this has happened several times in recent years. Should the new member intend to open on his own account he must prove to the Directors that his capital is at least £10,000, the minimum figure demanded by the Association. Two or three persons can form a firm with the same minimum capital and so long as one of them has bought a share, the firm has the rights of full membership. If an existing firm wishes to change its constitution, either by admitting another or others into its partnership, it must restate its capital to the Directors, or, in the case of a dissolution, the firm wishing to carry on must convince the Directors that it has the necessary funds to do so. Any firm or individual with direct cotton interests outside Liverpool can be elected as members, but has no voting privilege.

The Association is managed by a President, Vice-President, and Treasurer, elected annually, and 16 Directors who serve for three years. Any member can be nominated for the Board. The Association has full power over its members and in case of any violation of its rules and regulations, can fine, suspend or expel a member or firm. The Board of Directors meet weekly and when necessary call special meetings.

Various committees are elected annually for the business routine of the Association. Neither the President, Vice-President, Treasurer or Directors receive any fee from their office, but the respective committees pool the fees that are charged for what is known as "appeals". This can be explained as follows: any member may act as an arbitrator the fee for which is £1 1s. per 100 or part of 100 bales in American cotton. If either a buyer or a seller is not satisfied with the result of the arbitration he can appeal against the decision by making a payment of £3 3s. per 100 or part of 100 bales. It is these "appeal" fees that the committees share between them. Their decision is final, except in cases where one of the party is convinced that a grave error of judgment has been made. Should this happen, the plaintiff can, by depositing £10, appeal to the Directors stating his case and if they agree that a *prima facie* case has been made out, a special committee whose decision is binding is appointed to reconsider it. If he wins his £10 is returned. Last season the American appeal committee received about £700 each. There are over 300 rules and regulations which are being constantly added to, altered or deleted.

An official circular is published daily giving a quotation of every transaction that has taken place in each of the Future Rings, of which there are four (American, Egyptian, Indian, Empire), also the maximum and minimum prices that have been obtained for the various qualities of actual cotton that have been sold. In addition, a weekly circular is published giving the figures that are of vital interest to the whole trade. There is a special cotton bank which has two clearings each day. All contracts made between members, both for Futures and Spot cotton, are binding and cannot be cancelled on any ground while any differences or disputes arising therefrom must be settled by arbitration.

The official hours for trading in the Exchange are 10 a.m. to 4 p.m. and on Saturday 10 to 12 a.m. The Exchange receives from and sends to New York, New Orleans, Alexandria and Chicago the latest quotations, while the markets are open simultaneously every three to five minutes.

The official Futures Contract calls for weekly payment of differences, the prices being "struck" or fixed each Monday morning and the cash paid through the Association clearing house each Thursday. The commission charged on Futures orders vary according to the price of cotton, being higher as the price is lower and lower as the price is higher, but on all actual or Spot cotton transactions, the brokerage is ½ per cent. (10s. per £100) on the invoice price. Most firms have their own Ring Traders who are registered with the Association and only they and the members are allowed to trade in any of the Futures Rings. The price of every transaction is posted on the official boards and recorded in the daily circular printed at the close of each day. Should the transaction be for the minimum amount, *i.e.*, 100 bales in American, 33 bales Egyptian, 50 bales Indian, 50 Empire, a star is placed over the price; the star being removed if the same price has been paid within the period of two minutes.

There are two sets of official figures each day, the committee meeting at 12.15 p.m. for the mid day rates and at 4 p.m. for the closing prices. The estimated sales of actual cotton are posted each morning at 11 a.m. and in the afternoon a detailed account is given of how these sales have been made up. For example, if the sales were estimated at 5,000 bales the total may read like this, American 2,500, Egyptian 500, Peruvian 1,000, Brazils 500, Indian 500. Later in the week, each firm makes a return of all the cotton it has sold and forwarded to the mills or shipped abroad. In this way a minute check is kept upon the movement of all cotton.

Twice each year a return is made by each firm giving a detailed account of the actual number of bales stored in the warehouses and the warehouse owners also return the number of bales they hold so that a complete record and check of the stock held in Liverpool is made. A recent stocktaking showed that there were over 800,000 bales of various growths stored in the city.

Every known variety of cotton finds its way to Liverpool, thus making the market the largest and the cheapest in the whole world. Nearly all the members have had a difficult time during the past five years owing to the persistent fall in price and basis, because for every one bear there are quite ten bulls. With the suspension of the gold standard and the advance in the price of silver the prospects are now distinctly brighter.

Liverpool is the key of the cotton market as it is by the enterprize of its merchants that every known growth of cotton has been brought there, and given spinners the greatest selection from which they will be able to produce every conceivable quality of yarn that can be spun.

In recent years, Manchester has made much progress in selling actual cotton to the mills. Most steamship companies charge the same rate right through the canal to Manchester, as they do to Liverpool and many mills can cheapen their purchase price by the smaller transit charges from Manchester. But Manchester is not likely to become a serious rival as it has no Futures market to hedge its cotton and yarn, while its warehouse capacity is only sufficient for 200,000 whereas Liverpool can find room for 2,000,000 bales.

RANSOMES, LTD.

Messrs. Ransomes, Sims & Jefferies, Ltd., whose advertisement appears with this issue of the Journal, have recently forwarded us a fully illustrated catalogue of their ploughs and other implements. Of particular interest to the tropics are their "Shugadisc" plough for cane cultivation, a two "Dragoons" disc plough and a C.I. subsoiler, which are shown at work in Kenya. Their manufactures amongst many others include cotton and maize planters, rice thrashers and maize shellers. Further information can be obtained at any time from the firm whose address is Ipswich, England.

BANANA DISEASES.

3. Notes on the parasitism of Gloeosporium musarum (Cooke & Massee).

By C. W. Wardlaw.

Introduction.

Fruit rot caused by *Gloeosporium musarum* constitutes one of the most important sources of wastage in bananas and has accordingly received a considerable amount of attention at the hands of pathologists. Mycological observations made during bulk storage trials at the Low Temperature Station, Imperial College of Tropical Agriculture, Trinidad, B.W.I. (18, 19) called attention to the need for further investigation, and from the data accumulated the following notes have been prepared :

Anthracnose, black rot, or ripe fruit rot, has been found in all parts of the world where the banana is grown, the fruit being liable to infection in the field (1, 6, 11), in the local markets, and in large consignments during or after ocean transport.

Our present information regarding this disease is based on the work of Cooke (5), Cobb (3), Cook and Taubenhaus (4), Halsted (8), Agati (1, 2), Toro (16), Delacroix (7), Laubert (9, 10), Dastur (6), Savelli (12), Simmonds (13), and others. As the general information available has been summarised elsewhere (17), a detailed review may be omitted here.

Apart from the disease on bananas in the Philippines and on plantains in India (6) and Ceylon (11), where *Gloeosporium musarum* is active, not only on mature fruit in storage, but also on immature fruit in the field—a condition which has not been found in the western tropics—this fungus reaches its greatest economic importance as a cause of wastage when large consignments of fruit are approaching maturity. Such wastage does not lend itself to control based on the application of fungicides since it results mainly from injuries sustained during handling. Preliminary experiments conducted in Trinidad (18, 19), on the other hand, indicated that, provided fruit had not been excessively bruised by rough handling, the extent of *Gloeosporium* rot could be considerably reduced by the observation of suitable temperature relations during storage. A critical examination of this possibility led to investigations on disease incidence under different storage conditions, on fruit reaped at different stages of maturity*. The work of Tomkins (15) on Brazilian cargoes of the Cavendish variety points to *G. musarum* as an important cause of wastage, responsible on occasions for extensive finger-dropping.

* Fruit grown in the Caribbean lands for the English markets is reaped "¾-full". A period of some 36 hours elapses between reaping and loading of fruit into the holds. The temperature of the holds is reduced to and maintained at approximately 53°F. over a sea voyage of about 16 days. Thereafter the fruit is ripened in storage rooms at 70°F.

Types of Gloeosporium Fruit Rot.

Various types of *Gloeosporium* fruit rot have been recorded. Agati (1) describes the early stages of field infections as appearing in the form of small black spots on the flowers, skin and distal ends of the hands. The spots increase in size and as the disease reaches an advanced stage they become sunken and coalesce forming larger spots. When the infection is severe the whole fruit is covered with dark blemishes, on the surface of which characteristic bright salmon-coloured pustules appear. Dastur's (6) account of *Gloeosporium* rot of plantains includes a tip-rot and spotting, while Simmonds (13) has described it as associated with finger-stalk rot and with coalescing spots over the fruit surface. In Trinidad, *Gloeosporium musarum* has been observed as follows :—

1. As the cause of localised infections on the main-stalk and cushions (18).
2. Associated with abrasions and wounds on fingers, acquired during transport. Such infections are most frequently observed on the under-side of the fingers close to the distal ends.
3. On the short finger-stalks*, and chiefly responsible for finger-dropping.
4. As coalescing spots distributed generally over the fruit.
5. On small localised circular spots associated with insect punctures.
6. As the cause of a finger-tip rot (19).
7. Associated with the decayed perianth remains.

The fungus was isolated from the several types of infection and pure cultures sent to Mr. S. F. Ashby of the Imperial Mycological Institute for systematic investigation. An account of his observations is set out in the current issue of this Journal.

Occurrence of Infections.

On the information available the exact time at which the fungus becomes established is a question that presents several difficulties. Thus while Agati (1) found the fungus actively parasitic on immature green fruits in the field, and obtained proofs of pathogenicity by inoculation experiments, investigators elsewhere have been unable to obtain similar results. An account of the writer's experiments is set out in a subsequent section. A further difficulty in determining the time of infection is indicated by Dastur (6) who showed that dormant infections were frequently present and only became manifest as maturity was being approached during storage. Observations made in Trinidad (19) support this finding ; it was shown that fruit thoroughly sterilised superficially by washing with methylated spirits and flaming, when brought to maturity in aseptic containers,

* The individual banana fruit may conveniently be described as a "finger", and its short stalk as the "finger-stalk"; where several "finger-stalks" meet constituting a "hand" a crescentic "cushion" is formed. These "cushions" project from the "main stalk" of the whole bunch.

developed typical infections of *Gloeosporium musarum*. Thus the fruit may evidently become infected prior to reaping, although the duration of the period of dormancy has not been definitely ascertained. In discussing the time at which infection takes place seasonal conditions and accessory factors such as wounding agents must receive consideration.

Factors influencing Infection.

The factors which make for significant infection include atmospheric humidity, temperature, the presence of bruises or wounds, the degree of maturity and the susceptibility of the variety under consideration. The first is of fundamental importance since the conidia germinate freely in water but are quickly affected by drought (6). Agati observed that his experimental inoculations developed most rapidly during rainy days and also that field infections were most prevalent under such conditions.

The amount of disease developed on stored fruit is directly correlated with the degree of maturity and the extent to which injuries have been sustained. Delacroix (7) has maintained that *Gloeosporium musarum* is a wound parasite and can only bring about infections on wounded fruits, but Toro (16), on the other hand, found that completely matured bananas became diseased whether injured or not, a view which is supported by observations made in Trinidad. General experience indicates that it is exceedingly difficult to decide when any banana fruit is quite free from some form of injury.

Strains of Gloeosporium musarum.

The problem is further complicated by the fact that *Gloeosporium musarum* is represented by a considerable number of different strains. Toro described 11 in Porto Rico, and various strains are mentioned by other workers. During the present investigation some 40 isolations were made. Of these 32 were sent to Mr. Ashby for further investigation. By using standard culture media it soon became evident that a number of strains, with distinct differences both in general appearance and rate of growth, were present in this collection. The table below shows the characteristic types of infection from which distinct strains were isolated.

Number of Culture.	Variety of Banana.	Type of Infection.	Group*
7	Cavendish ..	Finger-stalk rot ..	1
9	Do. ..	Wound blemish ..	1
11	Do. ..	Tip-rot ..	1
19	Gros Michel ..	Puncture spot ..	2
20	Do. ..	Puncture spot ..	1
21	Cavendish ..	Dormant infection (after flaming)	1
29	Gros Michel ..	Fruit spot ..	2
32	Cavendish ..	Leaf spot ..	3

* This refers to Mr. Ashby's grouping of the several strains; (see the following article in this issue).

Five of the strains fall into Group 1 in Mr. Ashby's classification, and belong to the *normal type*, with conidia of uniform shape and size, the differences observed by the writer being megascopic and physiological. The relative pathogenicity of the several strains commends itself as a subject for further investigation.

Field Inoculations.

In order to test the pathogenicity of *Gloeosporium musarum* in the field, three strains, Nos. 9, 11 and 19 were inoculated into young fruits representing three stages of development, namely (*a*) very young fingers just after emergence of bunch, (*b*) slightly older, when the perianth had commenced to wither, and (*c*) fingers on a half-grown bunch. The method of inoculation adopted consisted in pricking the fingers at two or three points with a fine needle smeared with conidia. Twenty-four inoculations were made with each of the strains on each grade of maturity. Stabbing produced a copious flow of juice which dried up round the wound forming a little gummy pellet. Other fruits were inoculated by breaking off the perianth remains and applying conidia.

On examination at the end of sixteen days it was found that effective fungal penetration had not taken place. The needle stabs had acquired a brown corky appearance with a slight watery margin, closely resembling the insect punctures frequently observed on fruit. There was likewise no evidence of infection at the apical inoculations, a normal corky layer having apparently been formed.

On preparing sections through the stab inoculations, the wound appeared as a triangular incision in the skin having an outer margin of brown decayed cells and a well defined layer of cork cambium. Conidia and hyphae of *Gloeosporium* could be seen adhering to the decayed outer cells, but no penetration had taken place through the suberised walls.

When the experiment was again inspected on the twenty-eighth day, there was still no evidence of disease production. By this time the largest bunch was almost "$\frac{3}{4}$-full"; it was accordingly reaped and ripened at laboratory temperature. At maturity, after an incubation period of 40 days in all, no disease had developed in the inoculated areas, although other *Gloeosporium* infections of finger-stalks, &c., were present. At this stage the corky zone round the wound had enlarged and appeared as a slightly raised brownish cushion.

When the remaining bunches were examined in the field after a total incubation period of 41 days, no invasion of tissues had taken place. At the same time the blemished region round the stabs was observed to be more extensive, but this was found to be due to an enlargement of the cork cambium. Observations were continued till all the inoculated bunches reached maturity, but negative results were obtained throughout.

The experiments described above, conducted during the dry season, thus provided definite evidence that three typical strains of *Gloeosporium musarum* were unable to cause disease in the field, the preventive action being referable to the rapidity with which cork can be formed by immature fruit under such external conditions. A similar series of inoculations made during the rainy season likewise yielded negative results—a finding that is amply confirmed for Trinidad conditions by the fact that when several hundred bunches from different localities were being inspected during bulk storage trials, fruit spotting or rotting by *G. musarum* immediately after reaping was not observed.

Infection during Storage.

At whatever time the initial penetration may take place, the most striking aspects of wastage are undoubtedly to be observed when fruit is approaching maturity in storage. The types of infections that may become conspicuous have already been enumerated. As a rule a blackening of the skin takes place, followed by the appearance of pink, salmon, or orange coloured conidial pustules or acervuli. The extent to which the fruit flesh is affected varies, and different degrees of exploitation are quoted by the several investigators.

Disease effects are very readily obtained under laboratory conditions with green fruits, "full" or "$\frac{3}{4}$-full", by placing conidia on either wounded or unwounded surfaces. As maturity is being approached the spread of hyphae through the tissues is seen to take place more rapidly and dark blemishes appear round the inocula. This effect is produced more quickly in the case of wounded than unwounded specimens. Similar but less extensive infections can likewise be obtained when fruit, which has been inoculated and held at cool temperatures (*e.g.* 53° F.) for some time, is subsequently ripened at a higher temperature (70° F.). Characteristic results for fruit handled under trade conditions have already been described by Wardlaw and McGuire (18, 19).

In a series of inoculation experiments hands of fruit, representing a gradation in maturity from very young to "$\frac{3}{4}$-full", were sterilised in 2/1000 mercuric chloride, washed twice in sterilised water, and placed in large desiccators (28 litres capacity) each provided with a tube of soda-lime to take up the CO_2 of respiration. Each finger was then inoculated, by stabbing with a fine needle which had been previously immersed in a conidial pustule. After a preliminary period of six days specimens were removed at intervals for examination, and developments noted. The outstanding feature of all the inoculations, but particularly of those on the less mature fruits, was that fungal penetration remained very limited until normal saccharification had commenced to take place. In the case of *Botryodiplodia theobromae* (20), on the other hand, the presence of the pathogen induced an acceleration of this process, and consequently disease effects were greatly accentuated. *Gloeosporium musarum*, on the other hand, appears to possess such properties to a much less marked extent, and as a result its most active period of parasitism coincides with the normal maturation of the fruit when saccharification is completed.

Reduction in Wastage.

As already mentioned, reduction in wastage cannot be effected by measures based on the application of fungicides. It became necessary to determine, therefore, the extent to which *Gloeosporium* fruit rot and more especially finger-dropping could be reduced by the suitable manipulation of the temperature factor. Some results bearing on this aspect have already been published and further work is in progress.

Some of the more important conclusions from the practical standpoint may be stated as follows:—

1. The worst aspects of fruit-rot and finger-dropping result from those wounds or bruises where the infection has become thoroughly established at tropical temperatures. As most of such bruises are sustained during handling and local transport, the time between reaping and cooling in the ship's holds should be reduced to the minimum.

2. The fungus causes very little rotting when inoculated into wounds at the cool temperature of transport (53° F.).

3. Blemishes due to *Gloeosporium* do not become conspicuous until the fruit is approaching final maturity (*i.e.*, yellowing). Disease effects may therefore be considerably extended by slow ripening.

The control of fruit rot, then, depends on (*a*) reaping fruit at the correct stage of maturity (*b*) careful handling during local transport to minimise the extent of bruising (*c*) good organisation to curtail to the minimum the period of exposure of infected wounds to tropical temperatures (*d*) rapid cooling in the holds (*e*) careful handling during and after discharge from the holds (*f*) expeditious ripening.

Observations on the Invasion of Tissues.

Material from a tip-rot inoculation experiment was fixed, embedded, sectioned and examined in detail.

The fungus traverses the tissues of the skin by way of the middle lamellae and the air-spaces, while hyphae were also observed to pass freely through the walls from cell to cell. Penetration of a cell-wall is shown in Fig. 1, and the general distribution of hyphae below an acervulus in Fig. 3. When the spore-bed is about to be formed, hyphae accumulate in the vicinity of the epidermal tissues, and in particular, become conspicuously massed immediately below the cuticle. All stages leading to the formation of mature acervuli were observed. In the illustration it will be seen that the cuticle has been thrust upwards by the growth of the conidiophores. The remains of the epidermal cells are still distinguishable at the base of the spore bed,

the cells having been thrust apart by the passage of hyphae through the middle lamellae, while the cells, often filled with gum and tannin, have been freely invaded. The development of the acervulus is in general agreement with previous accounts (14). The vascular strands were also penetrated, and both in transverse and longitudinal sections, hyphae were observed in the vessels and surrounding tissues.

In the more open inner tissues of the skin, the hyphae were abundant, of larger diameter, and often considerably branched within the cells. Still further in, where the transition from skin to flesh takes place, hyphae were also conspicuous in the intercellular spaces, the middle lamellae, and cells. Before maturity is reached the latter contain starch grains, and it was found that these had apparently not been affected by the presence of the fungus, although the latter was often in the closest proximity, Fig. 2. From this fact, consistently observed, it may be concluded that the strain of *Gloeosporium* under examination exercises little diastatic activity in contact with the tissues of immature fruit. In cultural experiments, in which synthetic media were used, it was found, however, that the several strains of *Gloeosporium* possessed, in varying degrees, the power of decomposing starch, but this fell far short of the diastatic power of *Botryodiplodia theobromae* (20), also a parasite on banana fruits.

The presence of hyphae in cells filled with unmodified starch grains is particularly interesting in relation to two well-known features of fruit rot :

1. That the fungus only exploits the flesh as maturity is being approached, *i.e.*, as saccharification is proceeding, and

2. That the sweeter varieties are most markedly affected, while the less sweet varieties are not so subject to attack. Thus Agati (1) found that the sweeter varieties required 6 to 10 days for infection, while the less sweet varieties required 15 to 23 days—a conclusion which is also supported by Toro (16). The latter attempted to link the question of resistance with the tannin content of the peel but obtained negative results, from which he concluded that resistance and susceptibility are correlated with anatomical characters. Toro also demonstrated by enzymological studies that *Gloeosporium musarum* secretes an enzyme or enzymes capable of dissolving the parenchymatous tissue of mature but not immature fruit. This is in general agreement with the anatomical data set out above. The extent of infection therefore appears to depend on the maturity of tissues and the degree of saccharification reached.

In the later stages of infection the skin tissue is found to be necrosed, dark brown in colour, and freely penetrated by hyphae, but no active disintegration appears to take place.

Summary.

1. Fruit rot caused by *G. musarum* constitutes one of the most important sources of wastage in banana storage.

2. In Trinidad the fungus has been found as a parasite on main-stalks, finger-stalks (causing finger-dropping) and on the fingers, causing spots, blemishes and a conspicuous tip-rot.

3. The fungus is represented by a considerable number of different strains most of which belong to what may be regarded as the normal type.

4. While the fungus is known throughout the tropics on stored fruit it is only in the Philippines and in India and Ceylon that it has been recorded as a parasite on unreaped immature fruit.

5. Field inoculation experiments conducted in Trinidad during both the wet and dry seasons yielded negative results. Three strains of the fungus were used.

6. The greatest activity of the fungus is to be observed as the fruit is approaching maturity in storage.

7. Infections established at tropical temperatures are responsible for the major aspects of wastage in storage.

8. The control of fruit rot as it occurs when large consignments are undergoing ocean transport at 53° F. with subsequent ripening at 70° F. depends on

(*a*) reaping fruit at the correct stage of maturity ;
(*b*) careful handling during local transport ;
(*c*) curtailing to the minimum the period of exposure of infected wounds to tropical temperatures ;
(*d*) rapid cooling in the holds ;
(*e*) careful handling during and after discharge from holds ;
(*f*) expeditious ripening.

9. Observations are submitted on the invasion of tissues by hyphae.

The writer is very much indebted to Mr. S. F. Ashby of the Imperial Mycological Institute for kindly co-operating in this work by carrying out a systematic study of the several strains isolated. Thanks are also due to Professor H. R. Briton-Jones and Professor E. E. Cheesman for technical facilities provided by them.

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IMPERIAL BUREAUX LITERATURE.

The following reviews briefly some of the publications issued by several Imperial Bureaux :—

Bureau of Soil Science.

Technical Communications and *lists* of publications relating to soils and fertilizers. Issued since May, 1931 :—(*a*) twenty-one technical communications ranging in size from one page to 44 pages and in price from 6*d*. to 1*s*. 6*d*. ; (*b*) three lists of all current papers and pamphlets indexed by the Bureau, the title of the paper being given in English together with an abstract of two to three lines. Price 10*s*. per annum. Obtainable from the Director, Imperial Bureau of Soil Science, Rothamsted Experimental Station, Harpenden, Herts., England.

Bureau of Plant Genetics. (For crops other than herbage.)

Bibliographies issued periodically. *Plant Breeding Abstracts* issued quarterly, purely an abstracting journal containing references (classified according to subject, followed by an abstract giving the subject matter and the conclusions reached) to all the more important publications dealing with plant breeding and the genetics of crop plants. Papers divided into two classes—those published in the British Empire and those in foreign countries. Subscription, 5*s*. post free, single copies 1*s*. 6*d*. Obtainable from the Deputy Director, Imperial Bureau of Plant Genetics, School of Agriculture, Cambridge, England.

Bureau of Plant Genetics. (Herbage plants.)

Herbage Abstracts issued since June, 1931. Deals with herbage and certain forage crops, not only from the point of view of the plant breeder but also from that of the agronomist. Will also contain a section of miscellaneous notes, short extracts from official reports and proceedings of conferences. Subscriptions, 4*s*. for 1931 (three issues) and 5*s*. per annum thereafter, single copies 1*s*. 6*d*. Obtainable from the Chief Officer, Imperial Bureau of Plant Genetics, Agricultural Buildings, Aberystwyth, Wales.

Bureau of Fruit Production.

Horticultural Abstracts issued quarterly since May, 1931. All the more important horticultural literature is covered, special attention being attached to fruit production, cold storage and allied subjects. Subscription, 5*s*. per annum or 1*s*. 6*d*. per single copy. Obtainable from the Chief Officer, Imperial Bureau of Fruit Production, East Malling Research Station, East Malling, Kent, England.

Bureau of Animal Genetics.

Bibliographies issued periodically. *Bulletin of Animal Genetics* issued quarterly since December, 1929. Not specifically an abstracting journal but abstracts of current literature and reviews of books are a feature of each issue. Also includes notes on matters of interest arising out of the Bureau's correspondence and reviews of special subjects. Obtainable from the Bureau, King's Buildings, Edinburgh University, Scotland.

Bureau of Animal Health.

The Veterinary Bulletin issued since April, 1931, in place of the *Tropical Veterinary Bulletin*. Four parts published in 1931. From 1st January, 1932, will be published monthly. Deals with all aspects of animal health in so far as they relate to original research and administrative control. Subscription, £1 or 7*s*. 6*d*. a copy, post free. Obtainable from the Director, Veterinary Research Laboratory, Weybridge, Surrey, England.

Bureau of Animal Nutrition.

Nutrition Abstracts and Reviews. First published in October, 1931, in collaboration with the Medical Research Council and the Reid Library. Collects abstracts of all papers having a bearing on nutritional problems. Subscription, £1 1*s*., or 6*s*. 6*d*. per number (quarterly). Obtainable from the Secretary to the Committee of Management, *Nutrition Abstracts and Reviews*, Imperial Bureau of Animal Nutrition, Reid Library, Rowett Institute, Aberdeen, Scotland.

Bureau of Agricultural Parasitology.

Arrangements have been made for the *Journal of Helminthology*, of which the Director of the Bureau is Editor, to include a supplement giving titles, reviews and abstracts of papers and literature. Obtainable from the Bureau, Institute of Agricultural Parasitology, St. Albans, England.

TROPICAL WORLD NOTES.

Nyasaland.

According to the Director of Agriculture's Report for 1930, the principal crops grown by Europeans in Nyasaland are tobacco, cotton, coffee, sisal, rubber and tea and the following figures of the acreages planted to these crops show a reduction in the first three and an increase in the others.

	1929.	1930.
	acres.	*acres.*
Tobacco	19,269	17,481
Cotton	1,219	761
Coffee	1,331	1,256
Sisal	8,270	9,296
Rubber	1,330	1,405
Tea	8,866	9,686

The acreage planted with miscellaneous crops was 15,373 in 1930 and 19,892 in 1929. Tobacco is grown on a considerable scale by natives in Nyasaland, and production from this source in 1930 amounted to 4,233 tons, representing an increase of 352 tons over 1929. The number of registered native tobacco growers in 1930 was 48,419 against 47,578 in 1929.

The Empire Cotton Growing Corporation is carrying on in Nyasaland its good work of endeavouring to make the Empire independent of foreign cotton and promising results are recorded with strains of the U.4 variety. Although the production of European grown cotton shows a material reduction as compared with 1929, that grown by natives increased by 55 per cent. amounting to 5,448 tons of seed cotton against 3,505 tons in 1929.

Tea growing in Nyasaland is entirely in the hands of European agriculturists. The acreage increased from 8,866 in 1929 to 9,686 in 1930 and production from 778 to 850 tons. Prices paid for the product were low and it is felt that apart from the present depression, there is need to raise the quality of Nyasaland tea. Measures proposed to attain this end are the growing of shade trees and green manures and improvement in the various factory processes from withering to firing and grading. There has been a general adoption of ridge terracing as a measure of soil conservation and it is estimated that 85 per cent. of the tea land of the Protectorate has been so treated. It is proposed to institute a Tea Experimental Station in the Mlanje district under the auspices of the Department of Agriculture. It is hoped also to establish before long experimental coffee plots in different districts on which there will be investigated shade, green manuring, ground cover plants, methods of conservation of soil and soil moisture, pruning systems and pest control.

Uganda.

According to the *Report* of the *Department of Agriculture* for 1930, weather conditions during the year were generally favourable for the growth of all crops, although there were marked variations according to districts. There was a drop in the value of exports mainly accounted for by the lower prices for cotton lint and seed coupled with the reduced crop. Cotton represented 78.5 per cent. of the total exports and coffee 7.5 per cent. In Buganda the 1929-30 crop was marketed through the Buganda Seed Cotton Buying Association which operated in all parts of the Province until the end of March when it was dissolved. An interesting feature of the marketing in Buganda later in the season was the formation of a ginning company in which, for the first time, natives were directly interested. It is estimated that the 1930-31 crop will yield 170,000 bales.

With regard to coffee the acreage cultivated by natives has for the first time exceeded that of non-native coffee but the drop in prices which occurred towards the end of 1929 and the lower prices ruling during 1930 have prohibited any further increase by non-natives of the acreage under this crop during the year under review. In the Toro district where the bulk of the non-native *Arabica* coffee industry is situated a serious attack of *Antestia linealicollis* (variegated coffee bug) occurred and reduced the yield considerably on most estates. Much of the coffee, particularly the native-grown *Coffea robusta*, leaves the country in an unsatisfactory condition and, with the object of improving the grade of coffee exported, legislation was passed providing that on and after a date to be notified, all hulled coffee must have passed through a licensed curing works and be supported by an export certificate.

* * *

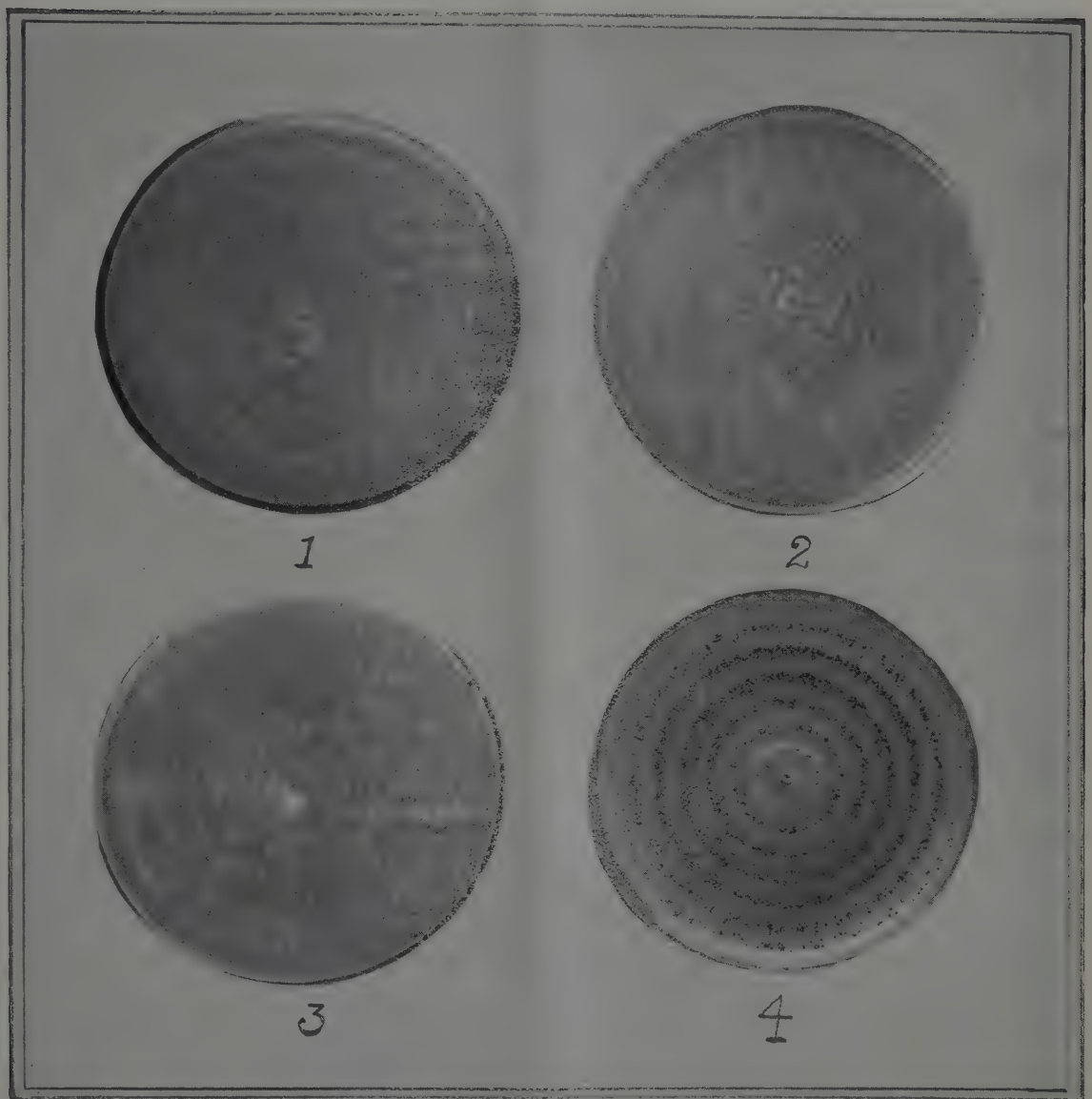
Java.

Messrs. Ochse* and de Jong have recently completed a Survey of the Fruit Industry of Java where they state that the cultivation, marketing and shipping of fruit is practically entirely in native hands. Fruit is not only consumed in large quantities locally but is exported to the Straits Settlements, British India, Australia, China, Japan, and the other islands of the Archipelago. The transport and packing facilities both for local and exportable produce, however, still leave much to be desired, and a number of remedial measures are recommended to deal with these problems. Exports from Java of fresh and dried fruit amounted in 1930 to over three and a half million kilogrammes valued at 446,000 f.† ; the fruits exported in order of importance being mangos ; citrus forms ; rambutans (*Nephelium lappaceum* L.) ; dukus (*Lansium domesticum* Corr.) ; sawos (*Achras zapota* L.) ; kesemeks (*Diospyros kaki* L.F.) and mangosteens (*Garcinia mangostana* L.). A considerable proportion of the fruit is grown within village compounds where it forms an additional source of revenue to the villagers.

* J. J. Ochse and W. de Jong. Vruchtenhandel en-cultuur in Nederlandsch-Indie. *Departement van Landbouw, Nijverheid en Handel.*

† One Florin=19.8 pence.

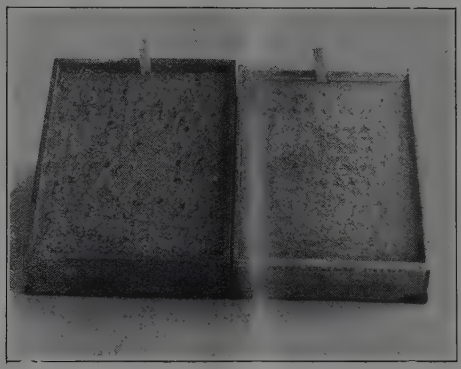
GLOEOSPORIUM STRAINS.



Strains of 'Gloeosporium musarum' Cke and Massee, grown on Brown's synthetic potato dextrose agar. 1, No. 9; 2, No. 21; 3, No. 20; 4, No. 29.

(Photographs by the Tucker Picture Coy.)

SEED STORAGE AND GERMINATION.



COOL STORAGE ORDINARY STORAGE

FIG. 1.—*Soybean germination after six months storage.*

COOL STORAGE ORDINARY STORAGE

FIG. 2.—*Soybean germination after ten months storage.*

SEED STORAGE AND GERMINATION.

The Use of Cool Storage in Retaining the Germinating Power of Some Oily Seeds.

By G. E. L. Spencer, Dip. Agric. (I.C.T.A.),
Department of Botany, Imperial College of Tropical Agriculture.

It is a well known fact that in tropical climates, where the temperature and the atmospheric humidity are both high, seed storage often presents problems which do not arise in such an acute form in temperate regions. Many seeds with a high oil content, in particular, seem to lose their germinating power in a comparatively short time despite full precautions taken in harvesting and drying.

Particular trouble has been experienced at the Imperial College with various strains of soybeans upon which, for several years, selection work has been carried out by post-graduate students. Beans harvested in April, thoroughly dried and then stored, gave a very poor germination when planted in November of the same year. A similar deterioration above what might be expected has been noted in the germinating capacity of cotton seed stored for any considerable time under ordinary conditions. Tempany (1) had already observed this in the Leeward Islands and stated that in seed which had been stored the resin masses tended to become ruptured causing a brown discoloration and disintegration of the internal tissues, but was unable to make clear whether these changes were causative or consequent factors of the decrease of the germination percentage. He also found that storage under very dry atmospheric conditions made no difference in germinating power as compared with ordinary storage.

The writer, at the suggestion of the Principal and with the kind permission of Dr. L. P. McGuire, officer-in-charge of the Low Temperature Research Station of the College, carried out two parallel series of germination tests on small quantities of soybeans and peanuts at intervals during a period of ten months. In one series the seeds were kept in the air-lock of the Station at a temperature of 55°F to 60°F, while in the other series the seeds were stored under ordinary conditions. The soybeans, a Darjeeling variety, had been reaped on the College plots only a short time previously while the peanuts were a recently harvested lot from St. Vincent.

It may be of interest to give here some idea of the climatic conditions obtaining during seed storage under ordinary conditions in Trinidad. From readings taken at the College Meteorological Station it is found that the average monthly maximum temperature varies between 83°F in the dry season (December to May) and 87°F in the wet, while the average monthly minimum varies between 65°F in the dry and 72°F in the wet season. With regard to humidity, this is relatively high, reaching saturation point almost every night. The average monthly minimum varies between 48 per cent. in the dry season and 64 per cent. in the wet season.

The germination tests on both lots of soybeans were carried out for each period on three samples of 100 beans each. The same applies to the peanuts except that for the last three trials it was found necessary to use smaller samples of those in ordinary storage owing to lack of material. The results of the tests are given in tables below :—

Soybeans.
Average Germination Percentages.

Period Stored Months.	Cool Storage.	Ordinary Storage.
0	96	96
2	100	99
4	100	83
6	99	59
8	100	19
10	100	11

Peanuts.
Average Germination Percentages.

Period Stored Months.	Cool Storage.	Ordinary Storage.
0	97	97
2	96	96
4	97	93
6	100	91
8	100	90
10	93	82

The soybean table needs little comment. The advantage of cool storage when beans are to be kept for more than four months before being planted is obvious. With regard to the peanuts the differences are by no means as striking although the percentage germination in ordinary storage appears to be decreasing with respect to that in cool storage. It may be shown however that this decrease is equal to 2.5714 ± 0.3707 per cent. per two months. This value is statistically significant and such differences would occur by chance in less than one in a hundred trials (2). (For $n=4$, $t=6.937$, $P > .01$).

It is proposed as opportunity offers itself to undertake germination tests on some other oily seeds in cool storage as against the same seed stored under normal conditions.

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CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Paper from Cotton Seed.

A method for manufacturing paper from cotton seed has recently been elaborated in the Hyderabad State in India. In a review of the possibilities of this new industry, K. R. Natarajan estimates that the annual cotton seed crop of India, amounting to about 2,000,000 tons, would be sufficient for the production of 50,000 tons of writing and printing paper, or alternatively, would provide all the paper pulp required by the Indian paper-making industry.

The raw material is obtained from the by-products of the cotton seed crushing industry. The short fibres which may be recovered from cotton seed, when treated in a defibrating machine, can be used in the process, the yield of crude usable fibre amounting to about four per cent. of the total weight treated. The non-cellulosic materials contained in the crude fibre are first digested with caustic soda, under steam pressure of 30 to 40 pounds per square inch, followed by bleaching with bleaching powder or electrolytic chlorine. An alternative method, consisting of bacterial digestion of the impurities present in the raw material, has been found to replace effectively the chemical method of treatment, with a considerable reduction in cost.

An estimate of the total costs of erecting and running a paper-making plant with a total daily capacity of about ten tons is included. It is based on the chemical method of treatment, and the figures quoted indicate that the proposition is economically sound.—(*Ind. and Eng. Chem., News Ed.*, Vol. IX, No. 18, p. 287, 1931.)

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Production of Alcohols and Hydrocarbons from Fats.

At the Deutsche Hydrierwerke A-G., Rodleben, Berlin, Schrauth has produced hydrocarbons and alcohols from fats by high pressure reduction. On heating coconut oil to 350° C. at 200 atmospheres, with nickel as catalyst, hydrocarbons are formed with the same carbon number as the original fats. When this same oil is subjected to 200 atmospheres at 320° C., with copper as catalyst, the alcohol corresponding to the fatty acid is produced. Thus lauric acid yields the hydrocarbon dodecane and stearic acid gives octodecane. Similarly, octyl alcohol and octadecyl alcohol are obtained from caprylic and stearic acids respectively.

In this way artificial waxes may be produced. By esterification of behenic acid, produced from hydrogenated rapeseed oil, with the docosyl alcohol obtained from this acid, it is possible to obtain a wax which contains 44 carbon atoms and has a melting point of 73° C. By esterification of montanic acid with montanic alcohol a wax is obtained with melting point 85° C.

It is not necessary to employ alcohols of high molecular weight in order to produce wax-like substances, since substitution in the alcohol component leads to the same end.—(*Ber. der. Deut. Chem. Gesell.*, 10th June, 1931.)

Preparation of Vinegar from Coffee Fruit Pulp.

The raw material is the pulp which covers the two seeds or beans of the coffee fruit, and which is freed from the seeds in the "wet process" of coffee preparation. The pulp is reduced to a mash in order to secure rapid and uniform fermentation. This mash is pasteurized at 75° C. for 45 minutes and then inoculated with a culture *e.g.*, of Saccharomyces octoporus. The temperature is kept between 23° and 25° C. and a good fermentation sets in within 24 hours, reaching its climax on the fourth day. After 12 days the fermentation is complete and clarification must follow.

The liquid is acidified in barrels filled with wood chips slaked in previously prepared strong vinegar and the temperature kept at 35° C. The vinegar which results is of a clear Rhine-wine colour, has a smell like pear oil and a taste resembling old whiskey. The taste disappears within three or four weeks of storage and the colour clears up somewhat. The specific gravity of the resulting product is 1.0154 and the total acid content, as acetic acid, is 4.60 per cent.—(*Ind. and Eng. Chem.*, Vol. XXIII, No. 10, p. 1108, 1931.)

* * *

Rubber Pickling Tanks.

No entirely satisfactory container for pickling has yet been found. In dealing with sulphuric acid, rubber linings have not been very satisfactory for the following reasons: soft rubber is very liable to physical damage, and the temperatures used are above the range normally considered satisfactory for it. The use of hard rubber is limited by the extreme temperature changes, which are very liable to cause cracking.

Underlying the success of Goodrich rubber-lined products in this field is the Vulcalock process, a method of vulcanization whereby soft elastic rubber can be attached directly to the surface of metals with an adhesion exceeding 500 lb. per square inch. In the Triplex system of construction use is also made of the advantages of both hard and soft rubber. This is a combination of hard and soft rubber plies, so arranged that the hard rubber plies are not united but overlap each other, thus offering the protection against physical damage of a hard rubber layer and arranged so that all the lap joints form expansion joints.—(*Fritz. Chem. and Inst. Eng.*, Vol. XXXVIII, July, 1931, page 396.)

* * *

Frozen Fruit Pulp.

Research workers of the Bureau of Chemistry and Soils, United States Department of Agriculture, have developed a new type of frozen fruit pulp. By pulping the pitted fruit, adding sugar syrup of proper concentration, mixing it thoroughly and then freezing at very low temperatures, a product has been obtained which has a remarkably smooth texture, while retaining the original flavour. Experiments have included peaches, apricots, plums, cherries, pears, raspberries and strawberries.—(*Ind. and Eng. Chem., News Ed.*, Vol. IX, No. 18, p. 285, 1931.)

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

New Plastic Product made from "Polymerized Sugar."

After more than nine years of research and experiment, a remarkable plastic substance made from sugar has been evolved by two well-known American technologists. The new material is being produced in New York in the various forms of a hard, insoluble, glass-like mass, transparent packing material, white transparent rubber and cellulose. It has been developed by Mr. Arthur S. Ford, a chemical engineer, and Mr. Benjamin Grey, an industrial consultant, who claim that it can now be produced for about nine and a half cents (4¾*d.*) per lb. According to Mr. Ford, the new substance is based upon the discovery of a new method of "polymerizing" sugar. "When treated in a certain way", he declares, "it assumes a hard and glassy consistency, while if the procedure is varied it becomes a water-white transparent 'rubber'; treated in a third manner, it becomes a cellulose film, whiter and more brilliant than celluloid, and a substance that is non-inflammable". Articles of clothing made from this spun sugar, boots and shoes made of "sugar leather" with heels of "sugar plastic", are claimed to be within sight of commercial production. Should the price of rubber boom again, the discoverers are confident their material would prove an effective synthetic substitute. It can be produced at a fraction of the cost of German synthetic rubber. Commercial production is expected within a few months, and those qualified to express an opinion have said that the new substance will provide an important outlet for some of the present large sugar surplus.

Mr. Arthur S. Ford, the inventor, is an Englishman, who became associated with Mr. Benjamin Grey three years ago to perfect the material. Mr. Grey was Public Relations Counsel of the American Sugar Institute at the time, and was seeking some new outlet for sugar. He did not, however, succeed in getting the Ford process accepted, so, believing strongly in it personally, he joined Mr. Ford and had patents taken out. Samples of the material in various forms took colours easily in tests. Among the uses contemplated are adhesives, textiles, lenses, photographic films, artificial leather, cartons, wrapping sheets, roofing tiles, paints, varnishes, decorative articles, filaments, threads and artificial rubber. It can be combined with cellulose nitrate and cellulose acetate, ingredients which substantially reduce the cost and make the combination an inflammable substance. At least two well-known sugar men in America have expressed their belief in the future of the product. Edward S. Paine, of the South Porto Rico Sugar Company, states that the new process is the most encouraging that the sugar industry has had for many years, and that, while it has always been felt that sugar had important uses other than as a sweetener, or food product, this is the first tangible evidence that this stage has been reached. Mr. Ellsworth Bunker, Chairman of the Prothero Sugar Company, and a member of the Board of the National Sugar Refining Company, New Jersey, declares that "as a new material, the substance is extremely interesting. It seems to be a good product on its own account, with some of the properties of Bakelite and such substances, and all sorts of articles could be made from it". The material was submitted to Mr. A. R. Burnette, a partner in Messrs. Krumbhaar and Burnette New York sugar engineers, who has reported on it as follows: "After an investigation of the physical aspects of this plastic material, as demonstrated by Mr. Ford, I am convinced that the matter will have a far-reaching effect on the sugar industry generally, and possibly prove more effective than any attempt to control world consumption." Mr. Grey states that the product has proved successful as the inner layer of unbreakable glass. "Rubbaglas" is the name given to the material when used in this way.—(*International Sugar Journal*, Vol. XXXIII, No. 394.)

* * *

Labour Saving Devices in Hawaii—The Diesel Loco.

Two Diesel locos were in use in 1929 for the first time on Kekaha and Waiakea plantations both of the Plymouth type, and both of 12 tons with two pairs of drivers. In each the motive power was provided by an 80 h.p. Atlas Diesel engine having a maximum operating speed of 650 revs. per min., the drive being similar to that used on some tractors and trucks.

The over-all thermal efficiency of the Diesel engine is about 33 per cent., whereas that of the most efficient steam loco is about one-quarter of this. Records of the cost of Diesel oil and lubricating oil state about $1.52 per day, taking the cost of the former at $0.052 and of the latter at $0.814 per gallon, whereas the corresponding expense for a steam loco doing the same work would be about $15, or a difference of as much as $13.48 per day.

It is true that the steam loco has proved to be extremely reliable under almost all conditions on a plantation; and whether the internal combustion loco will prove to be equally so can only be determined after it has been in use for some time. The cost of its repairs and upkeep will only be known after a number of years. However, the introduction of this type of loco on sugar plantations is an innovation of interest and in view of the extraordinarily low cost of fuel consumed by its engine is a development to be carefully watched. —(*Int. Sug. Jr.*, Vol. XXXIII, No. 393.)

ERRATUM.

Biological Control.

On page 303 of Vol. VIII, No. 11, first column, line 48, *The only effective Diatraea parasites . . .* should read *The only effective specific Diatraea parasites.*

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Market have ranged as follows (c.i.f. per cwt.) :—

	Foreign.	*Preferential.*
	s. d.	*s. d.*
1st October ..	6 6	10 3
8th October ..	6 11	10 $7\frac{1}{2}$
15th October ..	6 $10\frac{1}{2}$	10 $7\frac{1}{2}$
22nd October ..	6 $6\frac{3}{4}$	10 $4\frac{1}{2}$
29th October ..	6 6	10 3
5th November ..	6 6	10 3
12th November ..	6 6	10 3

The tone of the market since the issue of our last report has on the whole been quiet, prices assuming an easier tendency towards the third week of October. Although Licht's estimates showed a reduction in the total European crop of no less than 2,320,000 tons or, if Russia is excluded of 2,460,000 tons, these estimates had little or no effect on sugar values, although they have been accorded sufficient significance to bring about some improvement in sentiment. The domination of the sugar position by the fluctuations of Sterling has to some extent overshadowed statistical factors and such conditions, according to *Messrs. Czarnikow*, are likely to continue until Sterling finds a reasonably steady level. In spite of this, however, steady progress is being made towards a more balanced sugar position and this is especially so in the case of the European position.

* * *

TEA.—Tea prices have generally shown an upward tendency, advances being recorded in both Ceylon and Indian. The latest averages according to the *Times Trade and Engineering Supplement* include Ceylon, 18.57*d.*; Indian, 12.50*d.*; Java, 8.73*d.*; Nyasaland, 6.67*d.*; Darjeeling, 19.85*d.* Imports this year to date are (in millions of lb.) 350 against 361 in 1930 and 368 in 1929. Ceylon and China have much increased quantities.

* * *

BANANAS.—There has been an improvement in demand for Jamaicas since the last Summary, and prices remain at £16 per ton delivered London and £15 15*s.* per ton delivered nearest railway station. Brazilians are in fair demand, the price remaining at £15 15*s.* per ton delivered nearest railway station.—(*West India Committee Circular*, 15th October.)

* * *

COFFEE.—Prices have shown a slow upward tendency, Costa Rica making 147*s.* per cwt. for fine, Kenya, 85*s.* to 129*s.*, Uganda Robusta, 41*s.*, Good Blue Mountain from 122*s.* to 181*s.* 6*d.*

COCOA.—Since last writing the Accra Cocoa market has fluctuated again in sympathy with Sterling Exchange movements, there has however been rather more American buying interest for actuals. It is reported that unfavourable weather conditions are holding up supplies from the Coast and cocoa is not yet coming in in volume. The price of Accra cocoa is being quoted at 26*s.* ($6.24) c.i.f. whilst locally $8 a fanega is being paid for Plantation Cocoa.—(*By courtesy of the Cocoa Planters' Association of Trinidad, Limited.*)

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—

30th September	$2\frac{1}{16}$
7th October	3
14th October	$2\frac{15}{16}$
21st October	$3\frac{1}{16}$
28th October	$2\frac{7}{8}$
4th November	$2\frac{7}{8}$
11th November	$2\frac{15}{16}$

Any activity in the Rubber market since our last report has been mainly due to fluctuations in Sterling exchange. The statistical position remains unsatisfactory and it is believed that Governmental action may eventually be taken with regard to the commodity. In this connection it is hoped that the Dutch without whose co-operation nothing can be done will be willing to join in an international conference to consider the Rubber problem for all concerned.

* * *

COTTON.—The following are the official Spot prices in pence per lb. of the Liverpool Cotton Association :—

	American Mid.	*Egyptian F.G.F. Sakel.*	*Sea Island*		
			Good.	*Extra fine.*	*Prices paid this Week.*
2nd Oct.	4·31	6·60	—	—	
9th Oct.	4·56	7·10	—	—	—
16th Oct.	4·77	7·35	—	—	—
23rd Oct.	4·97	—	—	—	—
30th Oct.	5·05	—	—	—	—
6th Nov.	5·03	—	—	—	—
13th Nov.	—	—	—	—	—

There has been a good demand for all kinds of cotton, and there is now more general confidence in prices than there has been for several seasons while the undertone has been distinctly good. Some business has been done in Spot, West Indian Sea Island, lower qualities.

* * *

LIME PRODUCTS.—*Lime Oil.*—Handpressed is nominally valued at 60*s.*, but supplies being scarce no business is reported. Distilled is slow of sale, and supplies small, and quotations are nominally unchanged. *Lime Juice.* — Concentrated is quoted at £5, raw being neglected.—(*West India Committee Circular*, 15th October.)